

DOCUMENT RESUME

ED 197 158

CE 027 788

AUTHOR Arneson, R.: And Others
 TITLE Mountain Plains Learning Experience Guide: Electrical Wiring. Course: Electrical Wiring Rough-In.
 INSTITUTION Mountain-Plains Education and Economic Development Program, Inc., Glasgow AFB, Mont.
 SPONS AGENCY Office of Vocational and Adult Education (ED), Washington, D.C.
 BUREAU NO 498MH90008
 PUB DATE Oct 74
 CONTRACT 300-79-0153
 NOTE 281p.: Some pages may not reproduce well due to light print. For related documents, see CE 027 766 and CE 027 789.

EDRS PRICE MF01/PC12 Plus Postage.
 DESCRIPTORS Adult Education; Building Trades; Disadvantaged; Electrical Occupations; *Electrical Systems; *Electricians; Electricity; Family Programs; *Individualized Instruction; Instructional Materials; Learning Activities; Learning Modules; Postsecondary Education; *Vocational Education
 IDENTIFIERS *Electrical Wiring; Mountain Plains Program

ABSTRACT

One of two individualized courses included in an electrical wiring curriculum, this course covers electrical installations that are generally hidden within the structure. The course is comprised of four units: (1) Outlet and Switch Boxes, (2) Wiring, (3) Service Entrance, and (4) Signal and Low Voltage Systems. Each unit begins with a Unit Learning Experience Guide that gives directions for unit completion. The remainder of each unit consists of Learning Activity Packages (LAP) that provide specific information for completion of a learning activity. Each LAP is comprised of the following parts: objective, evaluation procedure, resources, procedure, supplemental sheets, study guide, and a LAP test with answers. The course is preceded by a pretest which is designed to direct the student to units and performance activities. (LRA)

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MOUNTAIN PLAINS LEARNING EXPERIENCE GUIDE:

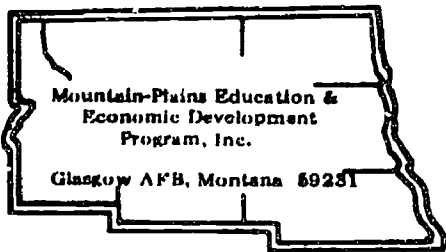
Electrical Wiring.

Course: Electrical Wiring Rough-In.

CE D27788

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Learning Experience Guide

COURSE: ELECTRICAL WIRING ROUGH-IN

DESCRIPTION:

The Electrical Wiring Rough-In Course contains the information and procedures for electrical installations that are generally hidden within the structure. Information and procedures presented and used are those established as better practice by the electrical industry and directed by the National Electrical Code. As a student, you will lay out, determine materials, requirements and install those parts of the electrical service that are considered part of the rough-in stage.

RATIONALE:

To be a qualified electrical wireman involves knowing what to do, when to do it and how to do it. The course will provide you with the background information and an opportunity to develop skills in electrical installation.

OBJECTIVES:

Identify the procedures for sketching layouts, estimating materials, and roughing in electrical wiring. Give blueprint specifications, National Electrical Codes, tools, building or shop simulation, students will sketch layouts, estimate materials required and make installations of electrical wiring in a rough-in mode. Success will be determined by adherence to the stated specifications under controlled conditions and by 80% accuracy on the multiple choice course tests.

PREREQUISITES:

Communication skills at the H-level.

RESOURCES:

Electrical Wiring Residential, Ray C. Mullin, Delmar Publisher, 1973.
A variety of electrical supply catalogs.
A variety of manufacturer's electrical products specification **guides**.
Electrical wireman's tools.

Principal Author(s): R. Arneson, L. Leland, and T. Ziller

RESOURCES: Continued

Film Loops:

The Third Wire Can Save Your Life, Wiring an Attachment Plug, Outlet Box Installation
Rewiring a Lamp, Wiring a Box with Armored Cable, Connecting Wires in an
Outlet Box, The Galvanometer, Installing a Convenience Outlet, Toggle Switch
Installation, The Wet Cell, Negative Charge, Positive Charge, Insulators and
Conductors, Liquid Conductors I and II, The Circuit, Series Circuit, Parallel
Circuit, Electromotive Force, Reversing Polarity, Series Circuit, Parallel Cir-
cuits, Dimmer Controls, Fairfield Associates, the Jam Handy Organization.

Audio Cassette Tapes.

Narrations for each of the film loops listed.

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GENERAL INSTRUCTIONS:

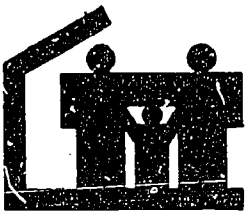
As a student you will be prescribed into **units and performance activities** according to the results on your comprehensive tests. **A unit guide will be given to you to read.** The guide will describe an assigned unit. After reading the unit guide you will be assigned performance activities unless you believe that you already have mastered the unit objectives. If you believe you have mastered the unit, request that you be tested. If mastery is shown, you will be given the next assigned unit guide. If you do not master the unit, you begin activities. Each activity has a LAP that describes it and gives the procedures to be followed. When you master the activity objective, you will be assigned the next activity. Mastery of an activity is accomplished by successfully completing a LAP test. You will be working independently unless directed otherwise. When questions or problems arise, you are to discuss them with the instructor.

UNIT TITLES:

- .01 Outlet and Switch Boxes
- .02 Wiring
- .03 Service Entrance
- .04 Signal and Low Voltage Systems

FOLLOW-THROUGH:

When you finish reading this course guide, you are ready for the first assigned unit in the course. Obtain the guide for that unit.



Family Education Program

SPECIFICATIONS FOR ELECTRICAL WIRING (Residential)

1. GENERAL -- The "General Clause and Conditions" shall be and are hereby made a part of this division.
2. SCOPE -- This contractor shall furnish all labor and materials to complete all electric wiring as shown on the drawings and/or specified herein. The contractor in accepting the contract agrees to have all equipment and wiring in working order at the completion of the job. This contractor shall verify with the architect or owner the location of all fixtures and outlets. If additional outlets are desired by owner, this contractor is to quote on same on a per outlet basis.
3. MATERIALS -- All material used shall be new and shall be listed by Underwriters' Laboratories, Inc., as conforming to its standards in every case where such a standard has been established for the type of material in question. The material shall be of the size and type specified on the drawings and/or in the specifications. This contractor is to assist the owner in the selection of lighting fixtures, fans and chimes.
4. WORKMANSHIP -- All electrical work shall be done in accordance with the standards of the National Electrical Code, local codes and ordinances, and the requirements of the local electrical utility. All work shall be executed in a neat and workmanlike manner. In setting outlet boxes, care shall be taken that same are securely fastened, set true and plumb, and flush with finished plaster, wall panel, or trim. Where tile back-splashes or the like are encountered, wall plates shall be entirely within the tile area or entirely out of the tile area.
5. WIRING -- In general, not more than ten (10) outlets shall be connected to any one lighting branch circuit. Exceptions may be made in the case of low-current-consuming outlets. Wiring is to be nonmetallic-sheathed cable or armored cable, adequately sized and installed according to the National Electrical Code and local ordinances. Minimum size is No. 12-2/WG AWG. Throughout the entire installation, all metal boxes, fixtures, appliances, etc., shall be grounded in accordance with the methods set forth in the National Electrical Code.

Basement wiring is to be installed in electrical metallic tubing except in the recreation room, passage, and lavatory which may be wired in cable as previously mentioned.

In the utility room, all wiring shall be concealed, and all wiring devices shall be flush-mounted on the Southeast, Southwest, and Northwest walls. Outside (Northeast) wall and ceiling of utility room to be exposed electrical metallic tubing.

General lighting branch circuits to be protected by 15-ampere overcurrent devices.

6. TELEPHONES -- Furnish and install 4 inch square boxes, 1-1/2 inches deep with suitable raised plaster covers at each of the five telephone locations as indicated on the plans. Install a 1/2 inch conduit from the living room, kitchen, and recreation room outlet boxes and terminate the three 1/2 inch conduits in the utility room. A 1/2 inch conduit shall be run from each of the bedroom outlet boxes and terminated in the basement

Family Training Center, Inc.

6. TELEPHONES (continued) -- storage and workshop respectively. Furnish four telephone jack plates to match the other wall plates. Kitchen phone will be wall-mounted. All other wiring and equipment will be furnished and installed by the telephone company. A short fish wire shall be left in each conduit for the convenience of the telephone installer.
7. FIXTURES -- An allowance of \$300.00 shall be made for all lighting fixtures and lavatory medicine chest. The Heat-A-Vent Light is not to be included in this amount.

All lighting fixtures and the lavatory medicine chest are to be selected by the owner and installed by the electrical contractor. Ceiling outlets are to be centered in the room or area that they are intended to illuminate unless otherwise noted. Lamps are to be furnished by the electrical contractor as part of the \$300 fixture allowance. Should the fixtures and medicine chest exceed the allowance, an additional charge will be made for the amount in excess of \$300.00.

The electrical contractor shall furnish and install 4-inch porcelain keyless receptacles:

Workshop	2	Pump room	1	Attic	1
Storage	1	Garage	3	Kitchen closet	1 pull-chain
Utility rm	2	Garage storage	1		

The electrical contractor shall furnish and install six recessed-type, 60-watt flush, solid glass lens fixtures, complete with lamps in closets in bedroom areas as indicated on the plans.














8. HEAT-A-VENT LIGHT -- Furnish and install one (1) Heat-A-Vent Light where indicated on the plans complete with switch assembly required to perform the heating, venting, and lighting operations as recommended by the manufacturer.
9. SPECIAL-PURPOSE BRANCH CIRCUITS -- Furnish and install all necessary material for the following special-purpose branch circuits. Make all necessary connections to the following equipment:

NOTE: Owner will furnish all of the following appliances except the two (2) 120-volt, 1750-watt electric heaters and the bathroom Heat-A-Vent Light which shall be furnished and installed by the electrical contractor. The owner shall furnish the range hood in the kitchen and the exhaust fan in the utility room but the contractor shall install this equipment.

(Please refer to page 3 -- SCHEDULE OF SPECIAL PURPOSE OUTLETS).

10. SMALL APPLIANCE CIRCUITS -- Install 20-ampere circuits according to the following:

Dining area	1 circuit
Kitchen	4 circuits (install split-circuit receptacles)
Workshop	1 circuit
Utility room	4 circuits (each receptacle on separate circuit)

SCHEDULE OF SPECIAL PURPOSE OUTLETS						
Symbol	Use	Voltage	Amp Rating	Poles	Wire Size	Circuit No.
 A _{1,2}	For connection of two 1750 watt heaters	120	20	1	12	A14 A16
 B	Water pump. (8 amps)	240	20	3	12	B (13-15)
 C	Water heater. Top element 2000 watts, bottom element 3000 watts connected for limited demand	240	20	2	12	B (18-20)
 D	Dryer (4700 watts)	120/240	30	2	10	B (17-19)
 E	Garage door openers (2) Each 5.8 amperes	120	20	1	12	A17
 F	Refrigerator-freezer 5.8 amperes	120	20	1	12	B3
 G	Counter-mounted cook top 7450 watts	120/240	40	2	8	B (14-16)
 H	Wall-mounted oven 6600 watts	120/240	30	2	10	B (10-12)
 I	Garbage disposal 7.2 amperes	120	20	1	12	B7
 J	Dishwasher. Motor 7.2 amperes, Heater 1000 watts	120	20	1	12	B5
 K	Bath Heat-A-Vent Light 1475 watts	120	15	1	12	A23
 L _{1,2,3}	For connection of 3 air condition- ers - 8 amperes each	240	20	2	12	A (9-11) A (10-12) A (13-15)
 M	Attic exhaust fan 5.8 amperes	120	15	1	12	A24

11. SIGNAL CIRCUITS -- Furnish and install two (2) recessed two-tone door chimes where indicated on the plans, complete with two (2) pushbuttons and suitable chime transformer. Allow \$60.00 for above items. Chimes and buttons to be selected by owner. If owner selects chimes and buttons resulting in total sum higher than \$60.00, an additional charge will be made for the amount in excess of \$60.00.
12. LUMINOUS CEILING -- Furnish and install diffusing plastic in valance in bathroom. Owner to select pattern of diffusing plastic for a sum not to exceed allowance of \$30.00. Wood framing by carpenter contractor.
13. PLUG STRIP -- Where noted, furnish and install multioutlet assemblies with outlets 18 inches O.C. In living room, switch alternate outlets as noted. In workshop, furnish grounding-type receptacles.
14. TELEVISION OUTLETS -- Furnish and install 4 inch square, 1-1/2 inch deep outlet boxes with single-gang raised plaster covers at each television outlet where noted on the plans. Mount at the same height as convenience receptacles. Furnish and install 75-ohm coaxial cable to each television outlet from a point in the corner of the workshop near the main service-entrance switch. Cables may be looped from outlet to outlet. Allow eight (8) feet of cable in workshop. Furnish and install T.V. plug-in jacks at each location. Wall plates are to match other wall plates in home. All other work done by others.
15. SWITCHES, RECEPTACLES, AND FACEPLATES -- All flush switches shall be of the quiet a.c.-rated toggle type. They shall be mounted 50 inches to center above the finished floor except where otherwise noted.

Convenience receptacles shall be mounted 12 inches to center above the finished floor except where otherwise noted. All convenience receptacles shall be of the grounding type. All wiring devices are to be provided with ivory handles or faces and shall be trimmed with ivory wall plates except in the kitchen, bath and lavatory where stainless steel, satin finish plates shall be used.

Convenience receptacles in the living room, bedrooms and kitchen shall be of the split-circuit design.

16. ELECTRIC HEATING -- Where indicated on the plans, furnish and install all resistance-type, baseboard electric heating units (240 volts) plus two 120-volt, 1750-watt portable electric heaters suitable for ceiling mounting in the workshop and utility room. These portable heaters to have integral thermostats.

Furnish and install wall-mounted thermostats where indicated on the plans. Dining area heating unit to be controlled with living room thermostat.

Wattage ratings of heating units to be determined in accordance with established methods of the local area, and must be of sufficient rating to maintain comfortable temperatures within the home under the most adverse condition expected in the locality. For this dwelling, the heating requirements have been determined as follows:

This contractor shall furnish and install overcurrent devices and conductors sized according to the National Electrical Code.

This contractor shall instruct the owner as to the amount of insulation and/or vapor barriers necessary to obtain optimum comfort for the occupants. Such insulation and/or vapor barriers shall be furnished and installed by the carpenter-contractor.

16. ELECTRIC HEATING (continued)

This contractor shall furnish and install humidistat for attic fan.

Room	Wattage	Volts	Circuit No.	Ampere Rating	Pole	Wire Size	Thermostat
Living Room	2500	240	A5-7	20	2	12	Yes
Dining Room	750	240	A5-7	20	2	12	LR thermostat
Kitchen	1250	240	A10-12	15	2	12	Yes
Front Hall	500	240	A9-11	15	2	12	Yes
Bedroom No. 1	1500	240	A2-4	15	2	12	Yes
Bedroom No. 2	1500	240	A1-3	15	2	12	Yes
Bathroom	500	240	A9-11	15	2	12	Yes
Recreation Room	3000	240	A6-8	20	2	12	Yes
Lovatory	500	240	A13-15	15	2	12	Yes
Workshop	1750	120	A14	20	1	12	Built into heater
Utility Room	1750	120	A16	20	1	12	Built into heater
TOTAL	15500						

17. DIMMERS -- Furnish and install one (1) 200-watt, flush-mounted, autotransformer-type dimmer where indicated on the plans to control the living room valance lighting. Furnish and install one (1) 600-watt, three-way electronic solid-state dimmer where indicated on the plans to control the dining room ceiling fixture.
18. SERVICE ENTRANCE -- Furnish and install one (1) 200-ampere, 120/240-volt, single-phase, 3-wire combination main pullout disconnect complete with fuses in workshop where indicated. Branch circuit protection in panel to incorporate Type SC time-delay, current-limiting fuses and shall be complete with blown-fuse indicator lights for each pole. Service-entrance conduit to be 2-inch rigid conduit extending through roof not to exceed three feet. Service-entrance conductors to be No. 2/0 RHW or equivalent. Bond and ground service equipment in accordance with the National Electrical Code.

Furnish and install all fittings necessary to complete the service entrance, including meter socket. Utility company to furnish and install meter.

Furnish and install one (1) twenty circuit 120/240-volt, single-phase, three-wire load center in utility room. Load center to have 125-ampere mains. Feed load center with three (3) No. 3 RHW conductors or equivalent protected by a 100-ampere, two-pole overcurrent device in main panel. Install conductors under basement floor in 1-1/4 inch rigid conduit. This panel to be fusible similar to main panel.

Circuit Directory cards shall be neatly typed and attached to their respective panels.

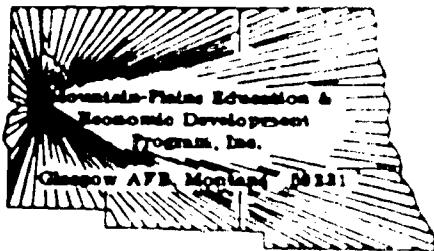
19. LOW-VOLTAGE, REMOTE CONTROL SYSTEM -- The electrical contractor shall submit an alternate bid on the following:

Furnish and install a complete low-voltage remote control system to accomplish the same results as would be obtained with the conventional switching arrangement as indicated on the electrical plans.

In addition, furnish and install one (1) 12-position master-selector switch in bedroom No. 1 or as directed by the architect or owner. Outlets to be controlled by this switch to be selected by the owner.

In addition, furnish and install two, motorized, 25 circuit master controls. These motor-operated controls shall be controlled from the front hall, bedroom No. 1, rear hall and garage or as directed by the architect or owner. Connect motor-operated master control in such a manner that each and every switch-controlled lighting outlet and switch-controlled convenience outlet may be turned off or on from the above-mentioned control stations.

All low-voltage wiring to conform to the National Electrical Code, Class II signal systems.



COURSE TEST: ELECTRICAL WIRING FOUNDATION

72.01.01.01 1. The code that establishes the minimum standards for electrical wiring is:

- a. NEC.
- b. EPC.
- c. UL.
- d. CEC.

2. Which of the following symbols indicate a power panel?

- a.
- b.
- c.
- d.

3. The electrical code provides _____ standards.

- a. maximum
- b. minimum
- c. equal
- d. equivalent

4. The certifying agency for electrical parts and supplies is:

- a. CEC.
- b. UL.
- c. EPC.
- d. NEC.

5. Which of the following symbols is a ceiling outlet?

- a.
- b.
- c.
- d.

72.01.01.02 6. How far from the curb line is the building location? (See Plans)

- a. 68'
- b. 13'
- c. 5'
- d. 50'

10. What is the size of the front entrance door? (See Plans)

- a. 2'8" x 6'8" x 1 3/8"
- b. 3'4" x 6'8" x 1 3/4"
- c. 2'6" x 6'8" x 1 3/8"
- d. 3'0" x 6'8" x 1 3/4"

11. Control wire entering and leaving a box is counted as:

- a. not counted
- b. one wire.
- c. two wires.
- d. three wires.

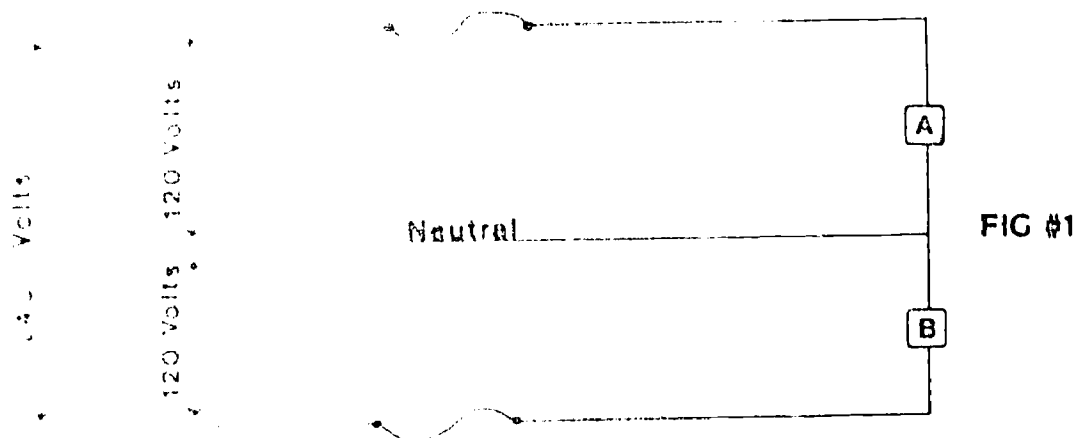
12. How many feet of base board electric heating units are indicated in the living and dining room area? (See Plans)

- a. 24'
- b. 30'
- c. 36'
- d. 40'

13. What is the size of the footing for the lally column in the garage? (See Plans)

- a. 16" x 24" x 12"
- b. 24" x 12" x 24"
- c. 24" x 24" x 12"
- d. 12" x 24" x 24"

72.01.01.03 In the diagram load A is rated at 10 AMPS, 120 Volts. Load B is rated at 5 AMPS, 120 Volts.



14. Using the diagram, what is the total resistance of circuit A?

- a. 5 ohms
- b. 10 ohms
- c. 15 ohms
- d. 12 ohms

12. If three wires are used to carry two circuits, the ground or white wire carries:
 - a. the unbalanced current.
 - b. all the resistance.
 - c. all the current.
 - d. the balanced current.
13. In a three wire system which carries two circuits, if one circuit carried 10 AMPS and the other circuit carried 12 AMPS. The neutral ground would carry:
 - a. 12 AMPS.
 - b. 120 AMPS.
 - c. 22 AMPS.
 - d. 2 AMPS.
14. Type UF cable is used:
 - a. when exposed.
 - b. when underground.
 - c. in house wiring.
 - d. in dry places.
15. ~~When connected to the three-wire circuit as indicated in Figure #1,~~
how much current will flow in the neutral conductor?
 - a. 5 AMPS
 - b. 10 AMPS
 - c. 15 AMPS
 - d. 20 AMPS

- 72.01.01.04
16. Each neutral wire entering and leaving a box is counted as:
 - a. one wire.
 - b. two wires.
 - c. not counted.
 - d. three wires.
 17. Which of the following symbols indicates a single pole switch with pilot?
 - a. SP
 - b. S₁P
 - c. S₁P
 - d. Sp
 18. What advantage does a 4 inch box have over a 3 1/4 inch octagon box?
 - a. has less conductor capacity
 - b. costs less
 - c. easier to mount
 - d. has more conductor capacity

19. What size is the opening of a switchbox for a single device?

- a. $1/4 \times 3$
- b. $1 \frac{3}{4} \times 2 \frac{3}{4}$
- c. $1 \frac{1}{2} \times 3$
- d. $1 \frac{1}{2} \times 2 \frac{1}{2}$

20. Electrical symbols on a drawing serve what function?

- a. drawings
- b. pictures
- c. shorthand notation
- d. sketches

72.01.01.05

21. To what material are the front entrance light and the front garage light fastened? (See Plans)

- a. concrete
- b. wood
- c. stone
- d. masonite





22. Which of the following phrases is used when a substitution of a 2W item is allowable?

- a. equal with
- b. equal to
- c. equivalent
- d. or equivalent

23. To avoid undue complexity on working drawings, the architect usually provides:





- a. building plans.
- b. plat plans.
- c. specifications.
- d. sketches.

24. Which of the following symbols indicates a floor outlet?

- a. 
- b. 
- c. 
- d. 


25. All ground wires entering and leaving a box are counted as:

- a. three wires.
- b. two wires.
- c. one wire.
- d. not counted.


- 72.01.01.06**
26. How many lighting fixtures would be in the circuit for bedroom No. 2 (see plan)?
 - a. three
 - b. four
 - c. one
 - d. two
 27. Flush mounted fixtures with reference to closets are considered in the electrical code to be:
 - a. outside the closet.
 - b. inappropriate.
 - c. inside the closet.
 - d. unacceptable.
 28. How many receptacles would be in the circuit for bedroom No. 2 (see plan)?
 - a. 7
 - b. 8
 - c. 5
 - d. 6
 29. The planning of circuits is usually left to the discretion of the:
 - a. electrical inspector.
 - b. homeowner.
 - c. architect.
 - d. electrician.
 30. For outlets, building plans typically do not specify:
 - a. wattage ratings.
 - b. amount.
 - c. location.
 - d. quantity.
- 72.01.01.07**
31. What advantage does a 4 inch box have over a 3 1/4 inch octagon box?
 - a. costs less
 - b. easier to mount
 - c. has less conductor capacity
 - d. has more conductor capacity
 32. Which of the following symbols indicates a floor outlet?
 - a. 
 - b. 
 - c. 
 - d. 

33. Which of the following is the symbol for a duplex outlet split circuit?

a.  **GWP**

b. 

c.  **WP**

d. 

34. The NEC states that the minimum wire size allowable in a house is which of the following?


a. 14 AWG


b. 12 AWG

c. 10 AWG

d. 18 AWG

35. Which of the following is the symbol for a duplex outlet?

a. 

b. 

c.  **WP**

d.  **GWP**

72.01.01.08 36. When counting the number of wires in a box, a wire that originates and terminates within the box is:

a. counted as two wires.

b. ignored.

c. counted as one wire.

d. not counted as a wire.

37. What are offset bar hangers used for?

a. to mount fixtures

b. to mount fluorescent lights

c. to mount power panels

d. to mount boxes

38. What is the size opening of a switch box for a single device?

a. 1 1/2 x 2 1/2

b. 1 1/4 x 3

c. 1 3/4 x 2 3/4

d. 1 1/2 x 3

39. To avoid undue complexity on working drawings, the architect usually provides a set of:
- a. plat plans.
 - b. sketches.
 - c. specifications.
 - d. building plans.

40. The code that establishes the standards for electrical work is:
- a. CEC.
 - b. EBC.
 - c. UL.
 - d. NEC.

- 72.01.01.09 41. What is the first floor story height? (See Plans)

- a. 8' 0"
- b. 7' 9"
- c. 8' 2 1/4"
- d. 7' 3"

42. Which of the following phrases is used when a substitution of an item is allowable?

- a. or equivalent
- b. equal with
- c. equal to
- d. equivalent with

43. What is the size of the front entrance door? (See Plans)

- a. 2'8" x 6'8" x 1 3/8"
- b. 3'0" x 6'8" x 1 3/4"
- c. 2'6" x 6'8" x 1 3/8"
- d. 3'4" x 6'8" x 1 3/4"

44. How many feet of baseboard electric heating units are indicated in the living and dining room area? (See Plans)

- a. 45'
- b. 35'
- c. 20'
- d. 25'

45. To what material are the front entrance light and the front garage light fastened? (See Plans)

- a. stone
- b. wood
- c. masonite
- d. concrete

- 72.01.01.10** 46. Each neutral wire entering and leaving a box is counted as:
- a. not counted.
 - b. three wires.
 - c. two wires.
 - d. one wire.
47. What is the size of the footing for the lally column in the garage?
(See Plans)
- a. 24" x 12" x 24"
 - b. 16" x 24" x 12"
 - c. 24" x 24" x 12"
 - d. 12" x 24" x 24"
48. How far from the curb line is the building location? (See Plans)
- a. 13'
 - b. 68'
 - c. 50'
 - d. 5'
49. All ground wires entering and leaving a box are counted as:
- a. not counted.
 - b. one wire.
 - c. three wires.
 - d. two wires.
50. A device mounted in a box is counted as:
- a. one wire.
 - b. three wires.
 - c. two wires.
 - d. not counted as a wire.
- 72.01.02.01** 51. When grounding a house, wherever possible, it should be grounded to:
- a. 10' pipe.
 - b. 24' pole.
 - c. 22' rod.
 - d. 2' pile aster.
52. What is the meaning of computed load?
- a. sum of volts in all branch circuits
 - b. sum of ohms in all branch circuits
 - c. sum of all branch circuit loads
 - d. sum of Watts in all branch circuits

53. Floor receptacles are not considered part of the required number of outlets unless they are:
- a. placed near an appliance.
 - b. placed near a light switch.
 - c. placed near a door.
 - d. placed near the wall.
54. What is the minimum number of 15 AMPERE lighting circuits if the dwelling has an occupied area of 4,000 square feet?
- a. 6
 - b. 9
 - c. 7
 - d. 8
55. What is the minimum size conductor allowable for outlets meant for small appliances?
- a. 14 AWG
 - b. 10 AWG
 - c. 12 AWG
 - d. 8 AWG
- 72.01.02.02** 56. Metal clad cable has a rating up to:
- a. 600 Volts.
 - b. 500 Volts.
 - c. 400 Volts.
 - d. 700 Volts.
57. The color code for 3 wire nonmetallic cable is:
- a. yellow-black-white.
 - b. black-white-green.
 - c. black-orange-red.
 - d. white-black-red.
58. When stapling NM cable, the intervals must not exceed:
- a. 4' 6"
 - b. 5'
 - c. 3' 6"
 - d. 2'
59. ~~NMC~~ cable must be strapped or stapled not more than how many inches from a box or fitting?
- a. 18"
 - b. 16"
 - c. 12"
 - d. 14"

60. The electrical code states that no point in any room shall be more than how many feet from a receptacle?

- a. 8'
- b. 6'
- c. 4'
- d. 10'

72.01.02.03

61. When does the code require special protection of cables run in the attics of houses?

- a. when access hole is provided
- b. when no access hole is provided
- c. when outside access hole is provided
- d. when stairs are provided

62. How close can outdoor receptacles be located near a swimming pool?

- a. 30'
- b. 20'
- c. 10'
- d. 40'

63. In what circuits may electronic solid state dimmers be installed?

- a. incandescent.
- b. none.
- c. all lighting circuits
- d. fluorescent

64. What type of lights are the cornice lights (see plan)?

- a. 30 Watt fluorescent par
- b. incandescent
- c. 150 Watt par
- d. fluorescent

65. From how many locations can the cornice lights be controlled (see plan)?

- a. one
- b. four
- c. two
- d. three





72.01.02.04

66. When stapling NM cable, the intervals must not exceed:

- a. 5'.
- b. 3'6".
- c. 2'.
- d. 4'6".





67. The ampacity of a wire depends on its wire:
- a. conductor (copper, aluminum).
 - b. size.
 - c. length.
 - d. make up.
68. According to the electrical code, in the kitchen and dining areas a receptacle must be placed at each:
- a. window.
 - b. cabinet.
 - c. counter.
 - d. lazy susan.
69. Nonmetallic sheathed cable may be installed:
- a. concealed and exposed.
 - b. inside.
 - c. outside.
 - d. in damp places.
70. What is the minimum size conductor allowable for outlets meant for small appliances?
- a. 10 AWG
 - b. 14 AWG
 - c. 12 AWG
 - d. 8 AWG

72.01.02.05

71. In a three-wire two-circuit system, how can the continuity of the neutral ground be accomplished?
- a. spliced
 - b. use a splice and pigtail the device
 - c. use a common connection on the device (electrical)
 - d. use the electrical device
72. A three-wire 115/230 volt branch circuit is the equivalent of how many receptacle branch circuits (115V)?
- a. three
 - b. two
 - c. four
 - d. one
73. Which of the following is a symbol for a thermostat?
- a. 
 - b. 
 - c. 
 - d. 

74. In a circuit with a breaker of 15 AMPS 110/120 volts, what is the total wattage allowable for this circuit (approximately)?
- a. 1040 Watts
 - b. 1240 Watts
 - c. 1440 Watts
 - d. 1540 Watts

75. Which of the following is a symbol for a clock?

- a. 
- b. 
- c. 
- d. 

72.01.02.06

76. How many speeds does the fan in the utility room have? (See Plans)

- a. one
- b. two
- c. three
- d. four

77. Which section of wiring must be exposed in the recreation room?

(See Plans)

- a. convenience receptacles in wall
- b. box over the fireplace
- c. ceiling fixtures
- d. exit door switches





78. The plaster cover of raised cover thickness is dependent upon which of the following?

- a. finish material
- b. box construction
- c. insulation thickness
- d. stud thickness

79. What type of receptacle is used in the recreation room? (See Plans)

- a. standard grounding
- b. standard
- c. split circuit
- d. split circuit switched

80. Which of the following is the accepted symbol for chimes?

- a. 
- b. 
- c. 
- d. 

- 72.01.02.07** 81. A garage that has a floor below grade level is considered by the code as what type of location?
- nonhazardous
 - indefinite
 - hazardous
 - residential
82. Which of the following is the garage floor (see plan)?
- 5" higher than the kitchen floor
 - 15" lower than the kitchen floor
 - 7 1/2" lower than the kitchen floor
 - level with the kitchen floor
83. Which section on the plan shows what the garage is lined with (see plan)?
- A-A
 - D-D
 - E-E
 - B-B
84. According to the code, when do garage lights require grounding?
- always
 - seldom
 - never
 - at times
85. What are the walls and ceilings of the garage lined with (see plan)?
- 3/8" sheet rock
 - 3/16" flex board
 - 1/2" rock
 - 3/16" sheet rock
- 72.01.02.00** 86. What is the maximum ampacity of a No. 3 RH Conductor installed in conduit in an area with a temperature of 95° F. (see code book 310-12 through 15) (rating of conductor is 100 AMPS)?
- 96 AMPS
 - 88 AMPS
 - 98 AMPS
 - 75 AMPS
87. Which of the following is the same as EMT?
- thin wall tubing
 - rigid tubing
 - armored cable
 - elec/tromotive/tubing

88. What size conduit would be needed for 3 No. 14 AWG assuming it is new work and insulated cable is used (see code book)?
- 1/2"
 - 1 1/4"
 - 3/4"
 - 1"
89. What size conduit would be needed for 5 No. 12 AWG assuming it is new work and insulated cable is used (see code book)?
- 1/2"
 - 3/4"
 - 1"
 - 1 1/4"
90. When determining conduit size, what is the percentage of fill if more than 2 conductors are to be installed?
- 80%
 - 40%
 - 60%
 - 20%
- 72.01.03.01** 91. If the conductor of a service entrance are AWG or larger, insulating bushings must be installed (373-6 (B)).
- 210 AWG
 - 8 AWG
 - 4 AWG
 - 0 AWG
92. With voltage between the conductors less than 300 volts and the feeders coming in through the roof, what is the maximum length up the roof (overhang) the cable can go over?
- 4'
 - 2'
 - 5'
 - 3'
93. Which of the following fuses has a rating of 100,000 AMPERES R.M.S. symmetrical?
- SC
 - Cartridge
 - SFC
 - SDFC
94. To insure a low impedance path to ground, a service entrance must be which of the following?
- banded
 - bonded
 - weather-proofed
 - grounded

95. Which of the following type fuses are required on all new installations?
- a. type S
 - b. type G
 - c. type X
 - d. type F

- 72.01.03.02** 96. The voltage maximum allowable with a bare neutral is which of the following?
- a. phase to ground
 - b. phase
 - c. ground to grounding
 - d. phase to phase
97. What is the minimum service drop clearance over a porch?
- a. 2'
 - b. 4'
 - c. 3'
 - d. 18"
98. What is the minimum size service entrance cable allowable by the NEC (copper)?
- a. 0 AWG
 - b. 210 AWG
 - c. 8 AWG
 - d. 6 AWG
99. If the voltage to ground is less than 300 volts, the grounded conductor need not be?
- a. copper.
 - b. insulated.
 - c. aluminum.
 - d. NMC.
100. If a service entrance cable passes over the peak of a house, what is the minimum clearance allowable?
- a. 4'
 - b. 10'
 - c. 6'
 - d. 8'
- 72.01.03.03** 101. Which of the following is not a standard size circuit breaker?
- a. 75 AMP
 - b. 60 AMP
 - c. 15 AMP
 - d. 25 AMP

102. Which of the following are required on service entrances?

- a. bonding bushings
- b. bushings
- c. bonding couplings
- d. couplings

103. Which of the following require mechanical protection under normal conditions?

- a. No. 8 grounding conductor
- b. No. 2 grounding conductor
- c. No. 4 grounding conductor
- d. No. 6 grounding conductor

104. The NEC states that the service drop includes all drops from a pole to and including which of the following?

- a. splices
- b. meter base
- c. power panel
- d. conduit

105. What part of a circuit breaker causes the breaker to trip on a short circuit?

- a. magnetic coil
- b. thermostat
- c. capacitor
- d. bimetal strip

72.01.03.05 106. How high up must mechanical protection be provided where underground service conductors are carried up a pole?

- a. 10'
- b. 6'
- c. 4'
- d. 8'

107. Disconnect devices must be in how many enclosures?

- a. two
- b. one
- c. four
- d. three

108. Which of the following is used to connect grounding conductor to a water pipe?

- a. EMT
- b. clamp
- c. coupler
- d. coupling

109. What is the minimum service drop clearance over a private driveway?

- a. 10'
- b. 12'
- c. 8'
- d. 14'

110. Where does a service entrance end?

- a. at the terminals of SE equipment
- b. at the terminal drop
- c. at the terminal's weather head
- d. at the conduit connection

72.01.03.06

111. Any house that uses electric cooking facilities must have a service entrance larger than which of the following?

- a. 80 AMP
- b. 60 AMP
- c. 125 AMP
- d. 100 AMP

112. What is the demand factor for the general lighting load of a house from 3,000 to 12,000 Watts?

- a. 35%
- b. 50%
- c. 25%
- d. 40%

113. If a wall mounted oven and a cooking unit total 14,000 Watts, what are the total Watts used to determine this single circuit load (220-5)?

- a. 14,050 Watts
- b. 7,500 Watts
- c. 8,800 Watts
- d. 5,500 Watts

114. In general, service entrance conductors shall not be smaller than which of the following?

- a. 2 AWG
- b. 4 AWG
- c. 8 AWG
- d. 6 AWG

115. If a house has 10 appliance circuits, what is the total load for appliance circuits in Watts?

- a. 10,000 Watts
- b. 15,000 Watts
- c. 20,000 Watts
- d. 25,000 Watts

72.01.04.01





116. An energy limiting transformer limits load to which of the following?

- a. 20 AMPS
- b. 30 AMPS
- c. 8 AMPS
- d. 4 AMPS





117. Which of the following does not control telephone installations?

- a. local telephone companies
- b. NEC
- c. state telephone requirements
- d. local authorities

118. Which of the following is a symbol for a push button?

- a. 
- b. 
- c. 
- d. 

119. Which of the following is a symbol for a telephone?

- a. 
- b. 
- c. 
- d. 

120. At what height are the outlets for television in the bedrooms set (see plan)?

- a. 5" to center
- b. 12" to center
- c. 2' 11" to center
- d. 18" to center

72.01.04.02

121. Unshielded TV input cable should not be installed near which of the following?

- a. wood members
- b. plastic
- c. pipes
- d. glass

122. What type boxes are recommended when non-shielded lead-in wire is used for a television circuit?
- DWV
 - special television
 - nonmetallic
 - metal
123. Television boxes are to have which of the following (see specs)?
- plaster covers
 - knockouts
 - nail mounts
 - screw mounts
124. How many wires must a cable have that is run between a rotor on a TV antenna and its controller?
- four
 - six
 - eight
 - two
125. If a TV outlet is to have both the low voltage outlet and 120 voltage in one box, what must be provided?
- a switch
 - a rheostat
 - it is not allowable
 - barrier between the two
- 72.01.04.03 126. Which of the following is the thermostat (see plan)?
- single-pole double-throw
 - double-pole single-throw
 - double-pole double-throw
 - single-pole single-throw
127. How many wires are required between a fluorescent lamp and its dimmer (less grounding)?
- five
 - two
 - four
 - three
128. With one exception the code book, section 410-71(E), requires that ballasts have:
- a protector.
 - a potential relay.
 - a switch.
 - a current relay.

129. What function does the dimmer on a fluorescent light perform?

- a. varies the resistance in the arc
- b. varies the current in the arc
- c. stabilizes the resistance in the arc
- d. varies the voltage in the arc

130. Where in the living room is the telephone jack located (see plan)?

- a. by the TV
- b. by the track fixture
- c. over the fireplace
- d. in the bookcase

72.01.04.04

131. Television boxes are to have which of the following (see specs)?

- a. nail mounts
- b. screw mounts
- c. knockouts
- d. plaster covers

132. At what voltage do residence chimes usually operate?

- a. 10 V
- b. 14 V
- c. 8 V
- d. 16 V

133. What is the size outlet box to be used in this residence for the television outlets (see specs)?

- a. $3 \frac{1}{2} \times 1 \frac{1}{2}$
- b. $4 \times 1 \frac{1}{2}$
- c. $4 \times 2 \frac{1}{8}$
- d. $3 \frac{1}{4} \times 1 \frac{1}{2}$

134. How many telephone locations are provided in this house (see plan)?

- a. three
- b. two
- c. five
- d. four

135. At what height is the telephone outlet installed in the living room?
(See Plans)

- a. 5' to center
- b. 12" to center
- c. 2' 11" to center
- d. 18" to center

72.01.04.05

136. What type of switch is used for controlling relays of a low voltage system?
- a. SPDT Momentary
 - b. SPST Momentary
 - c. DPDT Momentary
 - d. DTDV Momentary
137. Why do some manufacturers call for a rectifier tube installed on low voltage systems?
- a. to stop heat buildup
 - b. to vary the resistance
 - c. to provide constant amperage
 - d. to stabilize the voltage
138. Which of the following changes AC current to DC or pulsating direct current?
- a. rectifier
 - b. capacitor
 - c. diode
 - d. relay
139. The low voltage relay is essentially which of the following?
- a. a double rectifier
 - b. a double solenoid
 - c. a thermostat
 - d. a rectifier
140. What is the approximate maximum voltage used on low-voltage remote control systems?
- a. 8 volts
 - b. 24 volts
 - c. 32 volts
 - d. 16 volts

72.01.04.06

141. The low voltage relay is essentially which of the following?
- a. a thermostat
 - b. a double solenoid
 - c. a double rectifier
 - d. a rectifier
142. Which of the following is not an advantage of low voltage systems?
- a. safe
 - b. low cost
 - c. high cost
 - d. easily installed

143. What type of switch is used for controlling relays of a low voltage system?
- a. DPDT Momentary
 - b. SPDT Momentary
 - c. SPST Momentary
 - d. DTDP Momentary
144. Why do some manufacturers call for a rectifier to be installed on low voltage systems?
- a. to provide constant amperage
 - b. to vary the resistance
 - c. to stabilize the voltage
 - d. to stop heat buildup
145. What is the approximate maximum voltage used on low voltage remote control systems?
- a. 16 volts
 - b. 24 volts
 - c. 8 volts
 - d. 32 volts

COURSE TEST ANSWER KEY: ELECTRICAL WIRING ROUGH-IN

72.01.01.00

1. A
2. B
3. B
4. B
5. C
6. A
7. D
8. C
9. A
10. C
11. D
12. A
13. D
14. B
15. A
16. B
17. D
18. D
19. B
20. C
21. B
22. D
23. C
24. B
25. C
26. A
27. A
28. A
29. D
30. A
31. D
32. D
33. D
34. B
35. A
36. D
37. D
38. C
39. C
40. D
41. C
42. A
43. B
44. D
45. B

46. C
47. C
48. B
49. B
50. A

72.01.02.00

51. A
52. C
53. D
54. D
55. C
56. A
57. D
58. A
59. C
60. B
61. D
62. C
63. A
64. C
65. C
66. D
67. B
68. C
69. A
70. C
71. B
72. B
73. D
74. C
75. A
76. C
77. B
78. A
79. A
80. C
81. C
82. B
83. C
84. A
85. B
86. B
87. A
88. A
89. B
90. B

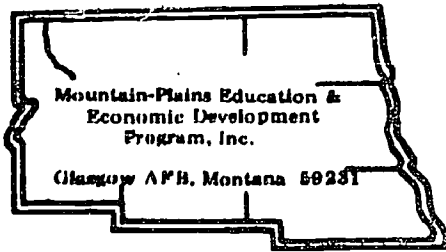
72.01.03.00

91. C
92. A
93. A
94. B
95. A
96. A
97. C
98. C
99. B
100. D
101. A
102. A
103. A
104. A
105. A
106. D
107. B
108. B
109. B
110. A
111. D
112. A
113. C
114. D
115. B

72.01.04.00

116. C
117. B
118. A
119. D
120. B
121. C
122. C
123. A
124. A
125. D
126. B
127. D
128. A
129. B
130. D
131. D
132. D
133. B

134. C
135. C
136. A
137. A
138. A
139. B
140. B
141. B
142. C
143. B
144. D
145. B



Learning Experience Guide

UNIT: OUTLET & SWITCH BOXES

RATIONALE:

The electrical wireman is expected to install various outlet, switch and junction boxes in structure planned to contain electrical circuitry. To install the specific boxes in their desired locations requires **several skills**. One skill includes the laying out or placement of the boxes using **the specifications and prints**. A second skill involves the selection of the desired **box from given specification**. A third skill to be developed is the **installation procedure**. Finally the installation skill that results in the satisfactory installation of outlet, switch and junction boxes.

PREREQUISITES:

This is the first unit of the Electrical Wiring Rough-In Course. In addition to the prerequisites listed in the course guide, are the following units from the D.C. circuit course, Current, and Voltage.

OBJECTIVES:

Identify types and characteristics of electrical outlet, switch, and junction boxes, and the procedure for installing them. Given blueprint specifications, National Electrical Codes, tools, building or shop simulation, students will sketch layouts, estimate materials required and make installations of outlet, switch and junction boxes.

RESOURCES:

Electrical Wiring Residential, Units 01, 02, 06 and 09, Delmar Publishers, 1973.

An assortment of electrical supply catalogs.

An assortment of manufacturer's electrical products specification guides.

Set of electrical wireman's tool.

Principal Author(s): R. Arneson, L. Leland, and T. Ziller

RESOURCES: Continued**Film Loops:**

The Third Wire Can Save Your Life, Wiring an Attachment Plug, Rewiring a Lamp, Outlet Box Installation, Wiring a Box with Armored Cable, Connecting Wires in an Outlet Box, The Galvanometer, Installing a Convenience Outlet, Toggle Switch Installation, Fairfield Associates.

The Wet Cell, "Negative Charge", and "Positive Charge", Fairfield Associates, the Jam Handy Organization.

Audio Cassette Tapes.

Narration for each of the film loops listed, Mountain-Plains Education & Economic Development Program, Inc.

GENERAL INSTRUCTIONS:

You have been prescribed into the first unit of this course. The activities that you perform will be assigned one at a time. A LAP will give you directions for each activity. Read the LAP and follow the procedure and directions given. When you finish the performance activities for the unit, you will be given a unit test. After the test you will be assigned then another unit in this course.

PERFORMANCE ACTIVITIES:

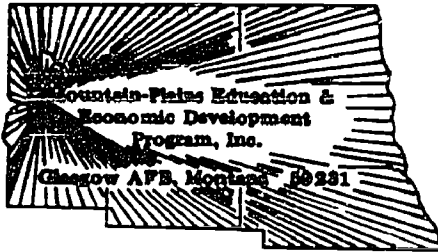
- .01 Laying Out Outlet Boxes on a Plan
- .02 Determining Type of Outlet Boxes
- .03 Installing Pilot Lights
- .04 Installing Outlet Boxes
- .05 Laying Out Switch Boxes on a Plan
- .06 Grounding Outlet Boxes
- .07 Installing Switch Boxes
- .08 Laying Out Junction Boxes on a Plan
- .09 Determining the Size of Junction Boxes
- .10 Installing Junction Boxes





EVALUATION PROCEDURE:

Success in this unit is determined by identifying 80% of the desired responses to a set of multiple choice test items and obtaining a "satisfactory" for completing each line item on a performance test.

FOLLOW-THROUGH:

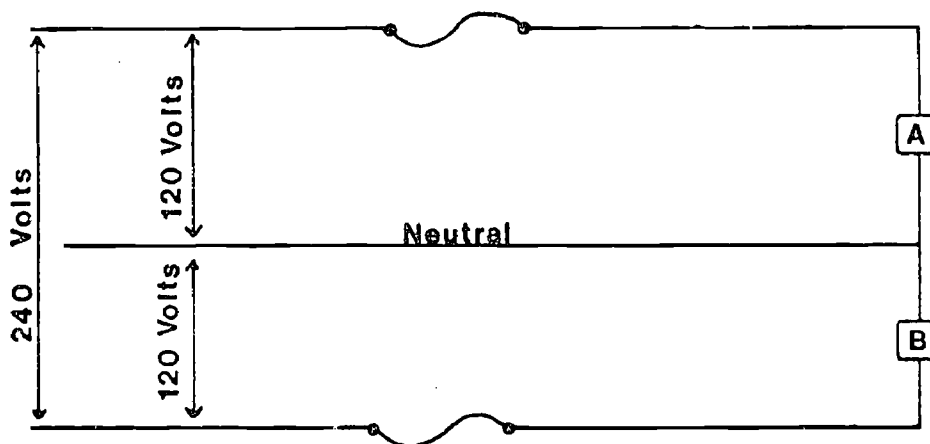
After you read this unit guide, begin reading the LAP for the first prescribed performance activity. You are expected to use the knowledge and skill acquired in the prerequisite courses when you do these activities.

**UNIT PRETEST: OUTLET AND SWITCH BOXES**

- 72.01.01.01**
1. Where are notations found on a plan?
 - a. next to a symbol, usually as abbreviations
 - b. in the specifications
 - c. on the plan letterhead
 - d. in the plan margin
 2. To avoid undue complexity on working drawings, the architect usually provides a set of:
 - a. sketches.
 - b. building plans.
 - c. plat plans.
 - d. specifications.
 3. Electrical symbols on a drawing serve what function?
 - a. pictures
 - b. shorthand notation
 - c. sketches
 - d. drawings
 4. Which of the following phrases is used when a substitution of an item is allowable?
 - a. equal with
 - b. equal to
 - c. equivalent
 - d. equivalent with
 5. Which of the following symbols indicates a duplex outlet?
 - a. 
 - b. 
 - c. 
 - d. 
- 72.01.01.02**
6. What is the size of the footing for the lally column in the garage?
(See Plans)
 - a. 24" x 12" x 24"
 - b. 24" x 24" x 12"
 - c. 12" x 24" x 24"
 - d. 16" x 24" x 12"

7. What is the size of the studding used in the partition between the bathroom and rear bedroom? (See Plans)
 - a. 2 x 6
 - b. 2 x 4
 - c. 2 x 2
 - d. 2 x 3
8. All ground wires entering and leaving a box are counted as:
 - a. not counted.
 - b. three wires.
 - c. two wires.
 - d. one wire.
9. How far from the curb line is the building location?
 - a. 68'
 - b. 50'
 - c. 13'
 - d. 5'
10. What is the size of the building lot? (See Plans)
 - a. 199' x 199'
 - b. 100' x 99'
 - c. 20' x 20'
 - d. 200' x 200'

72.01.01.03



In the diagram: Load A is rated at 10 amperes, 120 volts
 Load B is rated at 5 amperes, 120 volts

11. When connected to the three wire circuit as indicated, how much current will flow in the neutral conductor?
- a. 15 AMPS
 - b. 10 AMPS
 - c. 5 AMPS
 - d. 20 AMPS
12. Underground cables must be placed how deep in the ground at a minimum with no covering?
- a. 12"
 - b. 18"
 - c. 14"
 - d. 20"
13. Type UF Cable is used:
- a. when exposed.
 - b. in dry places.
 - c. in house wiring.
 - d. when underground.
14. In the diagram, with the neutral open what would be the RT?
- a. 48 OHMS
 - b. 12 OHMS
 - c. 24 OHMS
 - d. 36 OHMS
15. Using the diagram, what is the total resistance of circuit B:RT=?
- a. 24 OHMS
 - b. 14 OHMS
 - c. 12 OHMS
 - d. 28 OHMS
- 72.01.01.04** 16. Each neutral wire entering and leaving a box is counted as:
- a. two wires.
 - b. three wires.
 - c. not counted.
 - d. one wire.
17. A device mounted in a box is counted as:
- a. one wire.
 - b. three wires.
 - c. not counted as a wire.
 - d. two wires.
18. Boxes are measured by:
- a. outside opening.
 - b. inside opening.
 - c. circumference.
 - d. diagonally.

19. The electrical code provides _____ standards.
- a. equal
 - b. minimum
 - c. equivalent
 - d. maximum
20. The certifying agency for electrical parts supplies is:
- a. CEC.
 - b. EBC.
 - c. UL.
 - d. NEC.

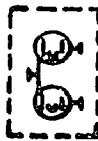
72.01.01.05

21. All ground wires entering and leaving a box are counted as:
- a. three wires.
 - b. one wire.
 - c. not counted.
 - d. two wires.
22. To avoid undue complexity on working drawings, the architect usually provides a set of:
- a. plat plans.
 - b. building plans.
 - c. specifications.
 - d. sketches.
23. When counting the number of wires in a box, a wire that originates and terminates within the box is:
- a. not counted as a wire.
 - b. counted as one wire.
 - c. ignored.
 - d. counted as two wires.
24. What is the size of the front entrance door? (See Plans)
- a. 2'8" x 6'8" x 1 3/8"
 - b. 3'0" x 6'8" x 1 3/4"
 - c. 3'4" x 6'8" x 1 3/4"
 - d. 2'8" x 6'8" x 1 3/8"
25. Outdoor convenience outlets are located how far above grade at a minimum?
- a. 12"
 - b. 48"
 - c. 36"
 - d. 18"

- 72.01.01.06** 26. How many receptacles would be in the circuit for bedroom No. 2 (see plan)?
- 8
 - 6
 - 7
 - 5
27. How many AMPS will a 60 Watt bulb draw?
- .58
 - 5
 - .5 AMPS
 - 5.8
28. How many lighting fixtures would be in the circuit for bedroom No. 2 (see plan)?
- two
 - four
 - one
 - three
29. What is meant by a split circuit receptacle?
- 2 circuits per receptacle
 - 1 circuit per receptacle
 - 4 circuits per receptacle
 - 3 circuits per receptacle
30. Which of the following is the symbol for a duplex receptacle grounding type?



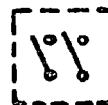
A



B



C







D

- 72.01.01.07** 31. How high above the finish floor are switches usually mounted?
- 65" to bottom of box
 - 12" to bottom of box
 - 48" to bottom of box
 - 36" to bottom of box
32. What are offset bar hangers used for?
- to mount fluorescent lights
 - to mount boxes
 - to mount power panels
 - to mount fixtures

33. All ground wires entering and leaving a box are counted as:
- one wire.
 - three wires.
 - two wires.
 - not counted.
34. What size is the opening of a switch box for a single device?
- 1 1/4 x 3
 - 1 1/2 x 3
 - 1 1/2 x 2 1/2
 - 1 3/4 x 2 3/4
35. What is the size wire and larger beyond which the conductors are not standard?
- 12 AWG
 - 6 AWG
 - 10 AWG
 - 8 AWG

72.01.01.08

36. When counting the number of wires in a box, a wire that originates and terminates within the box is?
- counted as two wires.
 - not counted as a wire.
 - counted as one wire.
 - ignored.
37. Which of the following symbols is a ceiling outlet?
- 
 - 
 - 
 - 
38. The code that establishes the standards for electrical work is?
- CEC.
 - NEC.
 - EBC.
 - UL.
39. Which of the following symbols indicates a single-pole switch with pilot?
- SIP

40. What size is the opening of a switch box for a single device?

- a. $1 \frac{1}{2} \times 2 \frac{1}{2}$
- b. $1 \frac{1}{2} \times 3$
- c. $1 \frac{3}{4} \times 2 \frac{3}{4}$
- d. $1 \frac{1}{4} \times 3$

72.01.01.09 41. Where is the attic access found?

- a. in the hall between bedrooms
- b. in the bedroom closet
- c. in the utility room
- d. in the hall from the garage

42. What is the size of the front entrance door?

- a. $2'6'' \times 6'8'' \times 1 \frac{3}{8}''$
- b. $2'8'' \times 6'8'' \times 1 \frac{3}{8}''$
- c. $3'4'' \times 6'8'' \times 1 \frac{3}{4}''$
- d. $3'0'' \times 6'8'' \times 1 \frac{3}{4}''$

43. What is the first floor story height? (See Plans)

- a. $7'3''$
- b. $7'9''$
- c. $8'2 \frac{1}{4}''$
- d. $8'0''$





44. When counting the number of wires in a box, a wire that originates and terminates within the box is:

- a. counted as two wires.
- b. ignored.
- c. counted as one wire.
- d. not counted as a wire.

45. All ground wires entering and leaving a box are counted as:

- a. three wires.
- b. two wires.
- c. one wire.
- d. not counted.

72.01.01.10 46. Which of the following symbols indicates a range outlet?

- a.  R
- b.  R
- c.  R
- d.  R

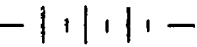



47. What size is the opening of a switch box for a single device?

- a. $1 \frac{3}{4} \times 2 \frac{3}{4}$
- b. $1 \frac{1}{2} \times 3$
- c. $1 \frac{1}{4} \times 3$
- d. $1 \frac{1}{2} \times 2 \frac{1}{2}$



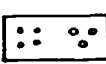

48. Each neutral wire entering and leaving a box is counted as:

- a. two wires.
- b. one wire.
- c. not counted.
- d. four wires.

49. Which of the following symbols indicates a battery?

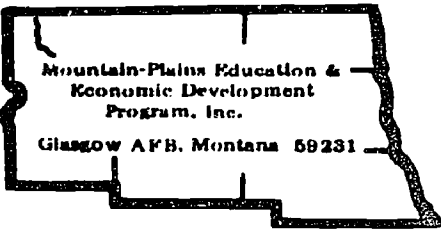
- a. 
- b. 
- c. 
- d. 

50. Which of the following symbols indicates a lighting panel?

- a. 
- b. 
- c. 
- d. 

UNIT PRETEST ANSWER KEY: OUTLET AND SWITCH BOXES

- | | | |
|--------------------|-----|---|
| 72.01.01.01 | 1. | a |
| | 2. | d |
| | 3. | b |
| | 4. | c |
| | 5. | c |
| 72.01.01.02 | 6. | b |
| | 7. | b |
| | 8. | d |
| | 9. | a |
| | 10. | d |
| 72.01.01.03 | 11. | c |
| | 12. | b |
| | 13. | d |
| | 14. | d |
| | 15. | a |
| 72.01.01.04 | 16. | a |
| | 17. | a |
| | 18. | b |
| | 19. | b |
| | 20. | c |
| 72.01.01.05 | 21. | d |
| | 22. | c |
| | 23. | a |
| | 24. | b |
| | 25. | d |
| 72.01.01.06 | 26. | c |
| | 27. | c |
| | 28. | d |
| | 29. | a |
| | 30. | a |
| 72.01.01.07 | 31. | c |
| | 32. | b |
| | 33. | a |
| | 34. | d |
| | 35. | d |
| 72.01.01.08 | 36. | b |
| | 37. | c |
| | 38. | b |
| | 39. | b |
| | 40. | c |
| 72.01.01.09 | 41. | d |
| | 42. | d |
| | 43. | c |
| | 44. | d |
| | 45. | c |
| 72.01.01.10 | 46. | c |
| | 47. | a |
| | 48. | a |
| | 49. | a |



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Learning Activity Package

Student: _____

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PERFORMANCE ACTIVITY: Laying Out Outlet Boxes on a Plan

OBJECTIVE:

Given the necessary tools, equipment, materials, supplies, and blueprint, sketch all outlet boxes. Sketch must correlate with information and standards identified in the resource text. Identify symbols used on electrical plans, materials, and equipment.

EVALUATION PROCEDURE:

Accurate completion of the sketch to the standards described in the text. Complete score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

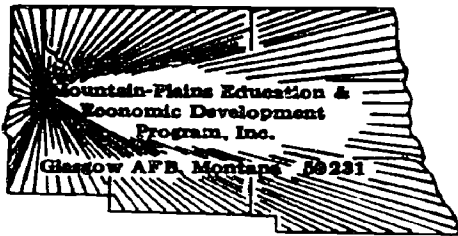
Electrical Wiring, Ray Mullin, pp. 7-25.

PROCEDURE:

1. Read the text reference, pp. 7-25, Units 1 and 2.
2. Answer the questions on pp. 9, 10, 21-25.
3. Using the blueprints from the packet in the back of "Electrical Wiring" resource, sketch on the back of this LAP, the outlet boxes necessary for bedroom #2.

NOTE: Make your sketches neat and clear. Follow the procedure presented in the text.

4. When you have completed steps 1-4, compile the requested data on your Performance Record.
5. Take the test for this LAP.
6. Score the LAP test and return it.
7. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory proceed as directed by the instructor.







LAP TEST: LAYING OUT OUTLET BOXES ON PLAN

1. The certifying agency for electrical parts and supplies is:

- a. NEC.
- b. EBC.
- c. CEC.
- d. UL.





2. Which of the following symbols indicates a battery?

- a.  B
- b.  B
- c.  B
- d.  B





3. Dash lines on an electrical plan:

- a. never are used to indicate switch connections.
- b. always are used to connect outlets.
- c. always are used to indicate switch connections.
- d. always indicate special purpose use.

4. Which of the following symbols indicates a power panel?

- a.  B
- b.  B
- c.  B
- d.  B

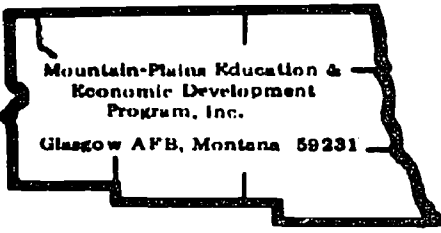
5. Which of the following symbols is a ceiling outlet?

- a.  B
- b.  B
- c.  B
- d.  B

6. Where are notations found on a plan?
 - a. on the plan letterhead
 - b. next to a symbol, usually as abbreviations
 - c. in the specifications
 - d. in the plan margin
7. Which of the following phrases is used when a substitution of an item is allowable?
 - a. equal to
 - b. or equivalent
 - c. equivalent with
 - d. equal with
8. What do the initials U/L stand for?
 - a. University Laboratory
 - b. Underwriters Laboratory
 - c. Underwriters Law
 - d. Universal Law
9. Which of the following symbols indicates a single-pole switch with pilot?
 - a. S_1P
 - b. S_p
 - c. \overline{SP}
 - d. $\overline{S_p}$
10. To avoid undue complexity on working drawings, the architect usually provides a set of:
 - a. plat plans.
 - b. sketches.
 - c. building plans.
 - d. specifications.

LAP TEST ANSWER KEY: LAYING OUT OUTLET BOXES ON PLAN

1. d
2. a
3. c
4. b
5. c
6. b
7. b
8. b
9. b
10. d



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Learning Activity Package

Student: _____

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PERFORMANCE ACTIVITY: Determining Types of Outlet Boxes

OBJECTIVE:

Given a blueprint and specifications, identify and record the type, description, and quantity of all outlet boxes on a requisition form. Completed data must correlate to and conform with the listed reference standards established in the industry. Identify information about type, quantity, and description of outlet boxes, connections, hangers and mounting devices from floor plans.

EVALUATION PROCEDURE:

Accurate ordering of the outlet boxes needed to complete bedroom 2 on given blueprint. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Supply Catalog.

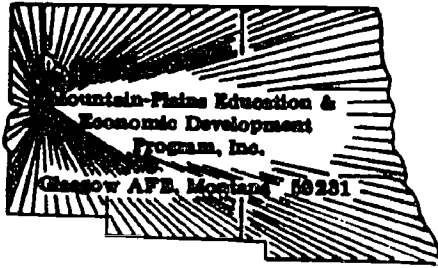
Electrical Wiring, Ray C. Mullin, pp. 7-25.

PROCEDURE:

1. Obtain an Electrical Parts Supply Catalog.
2. Using the attached "punched requisition" and the sketch you prepared in the "Laying Out Outlet Boxes on a Plan" LAP, order the parts and supplies needed to complete the bedroom #2 job.
NOTE: Parts and supplies must be ordered by quantity, complete description and type.
3. Check your requisition with the answer key.
4. Record the requested data on your Performance Record.
5. Take the test for this LAP.
6. Score the LAP test and return it.
7. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.



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**LAP TEST: DETERMINING TYPE OF OUTLET BOXES**

1. Where is the attic access found? (See Plans)
 - a. in the bedroom closet
 - b. in the utility room
 - c. in the hall between bedrooms
 - d. in the hall from the garage
2. How many feet of base board electric heating units are indicated in the living and dining room area? (See Plans)
 - a. 45'
 - b. 25'
 - c. 35'
 - d. 20'
3. How wide, approximately, is the concrete apron (NE to SW)? (See Plans)
 - a. 20' 0"
 - b. 3' 6"
 - c. 5' 5 1/2"
 - d. 1' 8"
4. What is the size of the footing for the lally column in the garage? (See Plans)
 - a. 24" x 24" x 12"
 - b. 16" x 24" x 12"
 - c. 12" x 24" x 24"
 - d. 24" x 12" x 24"
5. What material are the front entrance light and the front garage light fastened to? (See Plans)
 - a. wood
 - b. masonite
 - c. concrete
 - d. stone
6. A device mounted in a box is counted as:
 - a. two wires.
 - b. not counted as a wire.
 - c. three wires.
 - d. one wire.

7. All ground wires entering and leaving a box are counted as:
- one wire.
 - not counted.
 - two wires.
 - three wires.
8. What is the size of the front entrance door? (See Plans)
- 3'0" x 6'8" x 1 3/4"
 - 3'4" x 6'8" x 1 3/4"
 - 2'6" x 6'8" x 1 3/8"
 - 2'8" x 6'8" x 1 3/8"
9. What is the size of the studding used in the partition between the bathroom and rear bedroom? (See Plans)
- 2 x 6
 - 2 x 4
 - 2 x 3
 - 2 x 2
10. Each neutral wire entering and leaving a box is counted as:
- two wires.
 - not counted.
 - one wire.
 - three wires.

LAP TEST ANSWER KEY: DETERMINING TYPE OF OUTLET BOXES

1. d
2. b
3. b
4. a
5. a
6. d
7. a
8. a
9. b
10. a



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Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Installing Pilot Lights

OBJECTIVE:

Given the necessary tools, equipment, supplies and blueprint, correctly install pilot lights according to manufacturer's and blueprint specifications and following procedures and practices accepted in the industry; and outlined in the reference text. Identify characteristics of lighting branch circuits and underground cable applications.

EVALUATION PROCEDURE:

Installation meets the criteria listed on the attached checklist. Complete and score a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray Mullin, p. 81.
Manufacturer's Specifications.

PROCEDURE:

1. Read page 81 in text.
2. Go to an electrical mock-up.
3. Obtain the issued tools, pilot light, wire, connectors and mounting devices needed to meet specifications of the plans.
4. Install the pilot light on the appropriate mock-up following steps on the attached checklist.

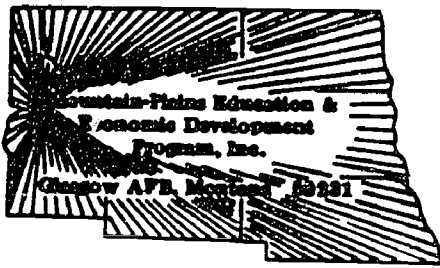
NOTE: FOLLOW SAFE PRACTICES AND PROCEDURES.

5. Have the instructor evaluate the installation.
6. Clean up the area.
7. Take the test for this LAP.
8. Score the LAP test and return it.
9. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

CHECKLIST: INSTALLING PILOT LIGHTS

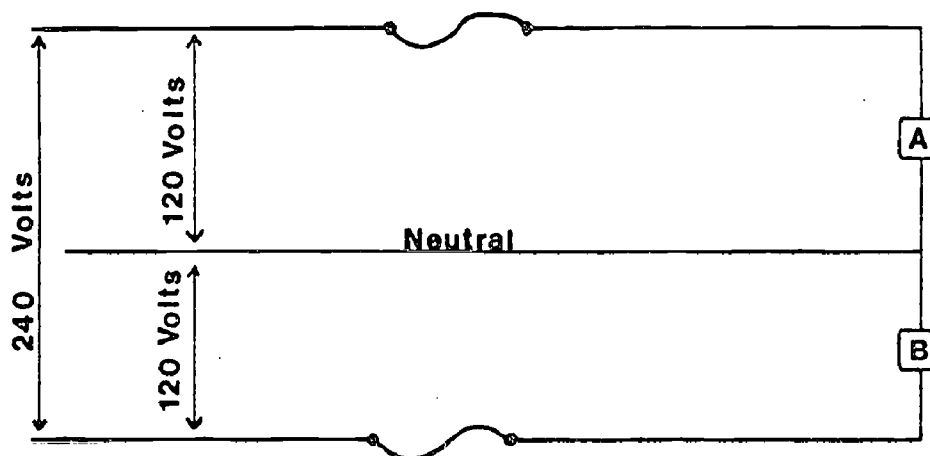
- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.



LAP TEST: INSTALLING PILOT LIGHTS

1. Underground cables must be placed how deep in the ground at a minimum with no covering?
 - a. 18"
 - b. 20"
 - c. 12"
 - d. 14"
2. In a three-wire two-circuit system, care must be taken to connect the black and red conductor to _____ phase source(s).
 - a. the same
 - b. one
 - c. different
 - d. three
3. Using the diagram, what is the total resistance of circuit A? (diagram on page 2)
 - a. 10 OHMS
 - b. 5 OHMS
 - c. 12 OHMS
 - d. 15 OHMS
4. In a three-wire two-circuit system, if the load on one circuit decreases, the load on the the other circuit:
 - a. decreases.
 - b. increases.
 - c. remains constant.
 - d. fluctuates.
5. In the diagram, if the neutral were to open, what type of circuit would it be? (diagram on page 2)
 - a. parallel
 - b. combination
 - c. series
 - d. parallel/series
6. When conductors carrying AC current are installed in metal enclosures, they shall be so arranged as to avoid heating the surrounding metal by:
 - a. induction.
 - b. conduction.
 - c. contact.
 - d. repulsion.

7. In the diagram, with the neutral open what would be the RT?
- 49 OHMS
 - 12 OHMS
 - 36 OHMS
 - 24 OHMS
8. Type UF cable is used:
- underground.
 - in house wiring.
 - when exposed.
 - in dry places.
9. If three wires are used to carry two circuits, the grounded or white wire carries:
- all the resistance.
 - the unbalanced current.
 - the balanced current.
 - all the current.
10. Which of the following identifies underground cable?
- NM
 - ACT
 - AC
 - UF



In the diagram: Load A is rated at 10 amperes, 120 volts
Load B is rated at 5 amperes, 120 volts

LAP TEST ANSWER KEY: INSTALLING PILOT LIGHTS

1. a
2. c
3. c
4. c
5. c
6. a
7. c
8. a
9. b
10. d

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Installing Outlet Boxes

OBJECTIVE:

Given the necessary tools, equipment supplies correctly install outlet boxes according to given specifications and following procedures and practices accepted in the industry; and outlined in the reference text. Identify the types and characteristics of outlet boxes. Identify the procedures for outlet box installation.

EVALUATION PROCEDURE:

Meet the criteria listen on the attached checklist. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray Mullin, pp. 11-25.
Manufacturer's Specifications.
Tool kit.

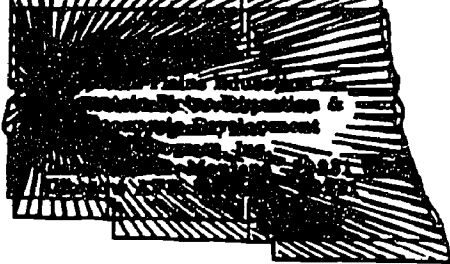
PROCEDURE:

1. Have your instructor assign a work area. Review the text if necessary.
2. Obtain the tools, outlet box and mounting devices install an outlet box.
3. Install the outlet box following the steps on the attached checklist.
NOTE: FOLLOW SAFE PRACTICES AND PROCEDURES.
4. Have the instructor evaluate the installations.
5. Take the test for this LAP.
6. Score the LAP test and return it.
7. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

CHECKLIST: INSTALLING OUTLET BOXES

- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.



LAP TEST: INSTALLING OUTLET BOXES
LAP TEST: INSTALLING OUTLET BOXES

1. Which of the following symbols is a ceiling outlet?

- a.
- b.
- c.
- d.

2. Electrical symbols on a drawing serve what function?

- a. shorthand notation
- b. shorthand notation
- c. drawings
- d. sketches
- e. pictures

3. All ground wires entering and leaving a box are counted as:

- a. three wires.
- b. one wire.
- c. not counted.
- d. two wires.

4. Each neutral wire entering and leaving a box is counted as:





- a. not counted.
- b. not counted.
- c. two wires.
- d. three wires.
- e. one wire.

5. What advantage does a 4 inch box have over a 3 1/4" octagonal box?

- a. easier to mount
- b. has more conductor capacity
- c. has less conductor capacity
- d. costs less

6. Boxes are measured:

- a. diagonally.
- b. by inside opening.
- c. by outside opening.
- d. by circumference.

7. Where are notations found on a plan?
- in the plan margin
 - on the plan letterhead
 - in the specifications
 - next to a symbol, usually as abbreviations
8. What are offset for hangers used for?
- to mount fluorescent lights
 - to mount boxes
 - to mount fixtures
 - to mount power panels
9. What do the initials U/L stand for?
- University Laboratory
 - Underwriters Law
 - Underwriters Laboratory
 - Universal Law
10. Which of the following symbols indicates a duplex outlet?
- 
 - 
 - 
 - 

LAP TEST ANSWER KEY: INSTALLING OUTLET BOXES

1. c
2. a
3. b
4. b
5. b
6. b
7. d
8. b
9. c
10. c

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Laying Out Switch Boxes on a Plan

OBJECTIVE:

Given floor plan and specifications for electrical work, sketch a floor plan and label all switch boxes. Identify the types and characteristics of switch boxes. Recognize print specifications related to switch boxes. Identify the procedures for sketching and layout of switch boxes.

EVALUATION PROCEDURE:

Sketch must be complete with information and standards identified in the resource text. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

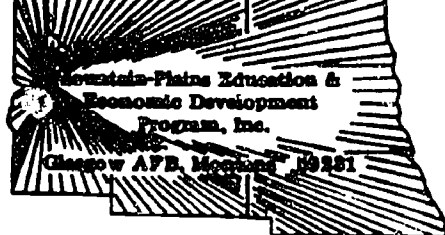
RESOURCES:

Electrical Wiring, Ray C. Mullin, pp. 7-25.





PROCEDURE:

1. Review the text reference pp. 7-25.
2. Using the "First Floor Electrical" plan and the resources listed as reference, sketch the switch boxes necessary for bedroom two that comply with the resource specifications.
NOTE: Make your sketches neat and clear. Follow the procedure presented in the text.
3. Record the requested data on your performance activity record.
4. Go to your instructor for evaluation and checkoff. Have the instructor initial your Performance in the appropriate space.
5. Take the test for this LAP.
6. Score the LAP test and return it.
7. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory proceed as directed by the instructor.

Principal Author(s): R. Arneson, L. Leland, T. Ziller



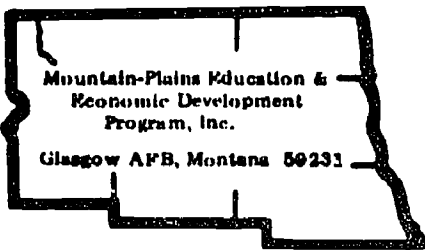
LAP TEST: LAYING OUT SWITCH BOXES ON A PLAN

1. All ground wires entering and leaving a box are counted as:
 - a. one wire.
 - b. three wires.
 - c. not counted.
 - d. two wires.
2. When counting the number of wires in a box, a wire that originates and terminates within the box is:
 - a. counted as one wire.
 - b. counted as two wires.
 - c. not counted as a wire.
 - d. ignored.
3. Three plates are to be mounted in a three-gang switch box. The wall plate for this location would be called a:
 - a. gang plate.
 - b. three-gang wall plate.
 - c. three-gang switch plate.
 - d. three-gang free plate.
4. How high above the finish floor are switches usually mounted?
 - a. 12" to bottom of box
 - b. 48" to bottom of box
 - c. 36" to bottom of box
 - d. 65" to bottom of box
5. Which of the following symbols indicates a floor outlet?
 - a. 
 - b. 
 - c. 
 - d. 
6. A device mounted in a box is:
 - a. not counted as a wire.
 - b. counted as one wire.
 - c. counted as three wires.
 - d. counted as two wires.

7. To avoid undue complexity on working drawings, the architect usually provides a set of:
- building plans.
 - specifications.
 - plat plans.
 - sketches.
8. Where is the attic access found? (See Plans)
- in the hall between bedrooms
 - in the bedroom closet
 - in the hall from the garage
 - in the utility room
9. What is the size of the front entrance door? (See Plans)
- 3'4" x 6'8" x 1 3/4"
 - 2'8" x 6'8" x 1 3/8"
 - 2'8" x 6'8" x 1 3/8"
 - 3'0" x 6'8" x 1 3/4"
10. Which of the following phrases is used when a substitution of an item is allowable?
- equal to
 - equivalent with
 - equal with
 - or equivalent

LAP TEST ANSWER KEY: LAYING OUT SWITCH BOXES ON A PLAN

1. a
2. c
3. b
4. b
5. b
6. b
7. b
8. c
9. d
10. d



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Grounding Outlet Boxes

OBJECTIVE:

Given the necessary tools, equipment, and supplies, correctly ground outlet boxes according to manufacturer's and blueprint specifications following procedures and practices accepted in the industry; and outlined in the reference text. Identify the types and characteristics of grounded outlet boxes. Recognize print specifications related to grounded outlet boxes. Identify procedures for grounding outlet boxes.

EVALUATION PROCEDURE:

Meet the criteria listed on the attached checklist. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring.
Manufacturer's Specifications.

PROCEDURE:

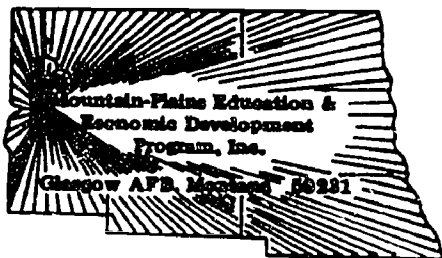
1. Read the last two paragraphs of "Use and Installation", p. 39 and p.p. 60-61 "Grounding Wall Boxes" in resource: Electrical Wiring.
2. Answer review question 12 on page 63.
3. Obtain the necessary tools, equipment, and supplies needed to complete the operations listed in the resource text.
4. Go to your assigned work station.
5. Ground outlet boxes.
NOTE: FOLLOW SAFE PRACTICES AND PROCEDURES.
6. Perform all necessary testing and evaluation checks listed in the checklist. If you have any questions or problems, check with the instructor.
7. When you have been checked off on the checklist by the instructor, complete the data requested on your Performance record and have him initial it.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

8. Clean up the area.
9. Take the test for this LAP.
10. Score the LAP test and return it.
11. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

CHECKLIST: GROUNDING OUTLET BOXES

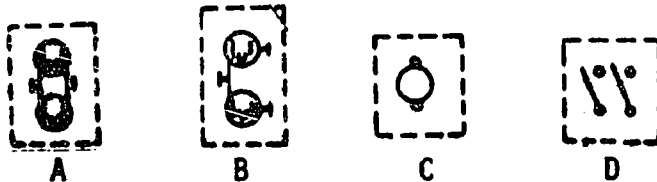
- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.



LAP TEST: GROUNDING OUTLET BOXES

1. The planning of circuits is usually left to the discretion of the:
 - a. homeowner.
 - b. architect.
 - c. electrician.
 - d. electrical inspector.
2. For outlets, building plans typically do not specify:
 - a. quantity.
 - b. wattage ratings.
 - c. amount.
 - d. location.

3. Which of the following is a two-gang switch box symbol?



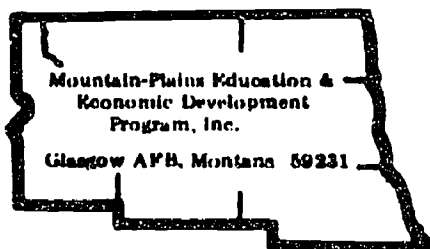
4. How many receptacles would be in the circuit for bedroom No. 2 (see plan)?
 - a. 8
 - b. 7
 - c. 5
 - d. 4
5. What type switches are indicated in the plan for the bedroom circuitry? (See Plans)
 - a. three way
 - b. single pole
 - c. double pole
 - d. four way
6. Which of the following is the symbol for a duplex receptacle grounding type?



7. In reference to pendants in closets, the electrical codes states they may:
 - a. be installed vertically.
 - b. be used in certain cases.
 - c. not be used.
 - d. be used.
8. Fluorescent fixtures are marked with their maximum lamp wattage and ballast:
 - a. power.
 - b. wattage.
 - c. voltage.
 - d. current.
9. What is meant by a split circuit receptacle?
 - a. 2 circuits per receptacle
 - b. 3 circuits per receptacle
 - c. 1 circuit per receptacle
 - d. 4 circuits per receptacle
10. Some electricians consider it poor practice to include outlets on different floors on the same:
 - a. switch.
 - b. ground.
 - c. source.
 - d. circuit.

LAP TEST ANSWER KEY: GROUNDING OUTLET BOXES

1. c
2. b
3. d
4. b
5. b
6. a
7. c
8. d
9. a
10. d



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Installing Switch Boxes

OBJECTIVE:

Given the necessary tools, equipment, and supplies, correctly install switch boxes according to manufacturer's and blueprint specifications and following procedures and practices accepted in the industry; and outlined in the reference text. Identify the procedure for installing electrical switch boxes.

EVALUATION PROCEDURE:

Meet the criteria listed on the attached checklist. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray Mullin, pp. 11-25.

Manufacturer's Specifications.

Film: Toggle Switch Installation.

Tape: "Toggle Switch Installation".

PROCEDURE:

1. Listen to tape and view film, Toggle Switch Installation.
2. Go to your assigned work station. Review the text if necessary.
3. Obtain the necessary tools, equipment and supplies needed to complete the operations listed.
4. Complete the job listed in the objective.
NOTE: FOLLOW SAFE PRACTICES AND PROCEDURES.
5. Perform all necessary testing and evaluation checks listed in the checklist. If you have any questions or problems, check with the instructor.
6. When you have been checked off on the checklist by the instructor, complete the data requested on your Performance Record and have him initial it.

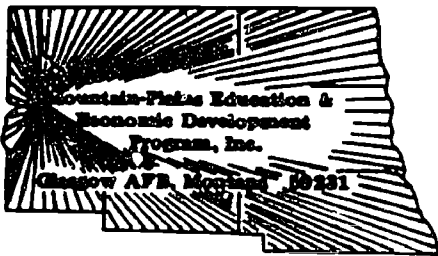
Principal Author(s): R. Arneson, L. Leland, T. Ziller

7. Clean up the area.
8. Take the test for this LAP.
9. Score the LAP test and return it.
10. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory proceed as directed by the instructor.

8

CHECKLIST: INSTALLING SWITCH BOXES

- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.

LAP TEST: INSTALLING SWITCH BOXES

1. What are offset bar hangers used for?
 - a. to mount boxes
 - b. to mount power panels
 - c. to mount fluorescent lights
 - d. to mount fixtures
2. What do the letters AWG stand for in electrical terminology?
 - a. aluminum wire gauge
 - b. advanced wattage gauge
 - c. American wire gauge
 - d. ambient weather gauge
3. What size is the opening of a switch box for a single device?
 - a. $1 \frac{1}{4} \times 3$
 - b. $1 \frac{3}{4} \times 2 \frac{3}{4}$
 - c. $1 \frac{1}{2} \times 2 \frac{1}{2}$
 - d. $1 \frac{1}{2} \times 3$
4. The NEC states that the minimum wire size allowable in a house is which of the following?
 - a. 10 AWG
 - b. 10 AWG
 - c. 12 AWG
 - d. 14 AWG
5. What is the size wire and larger beyond which the conductors are no longer standard?
 - a. 6 AWG
 - b. 12 AWG
 - c. 10 AWG
 - d. 8 AWG
6. Boxes are measured:
 - a. by circumference.
 - b. diagonally.
 - c. by inside opening.
 - d. by outside opening.





7. Outdoor convenient outlets are located how far above grade at a minimum?

- a. 18"
- b. 12"
- c. 48"
- d. 36"





8. When counting the number of wires in a box, a wire that originates and terminates within the box is:

- a. counted as two wires.
- b. ignored.
- c. not counted as a wire.
- d. counted as one wire.

9. Which of the following is the symbol for a duplex outlet?

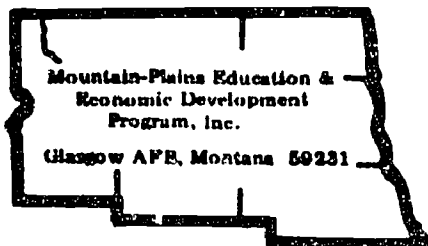
- a. 
- b. 
- c. 
- d. 

10. Which of the following is the symbol for a duplex outlet split circuit?

- a. 
- b. 
- c. 
- d. 

LAP TEST ANSWER KEY: INSTALLING SWITCH BOXES

1. a
2. c
3. b
4. c
5. d
6. c
7. a
8. c
9. a
10. b



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Laying Out Junction Boxes on a Plan

OBJECTIVE:

Given the necessary tools, equipment, materials, supplies, and a floor plan, sketch in and label all junction boxes. Sketch must be complete with information and standards identified in the resource text. Identify the types and characteristics of junction boxes. Recognize print specifications related to switch boxes. Identify the procedures for sketching and laying out junction boxes.

EVALUATION PROCEDURE:

Accurate completion of the sketch to the standards described in the text. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray C. Mullin, pp. 7-25.

Film: The Wet Cell, Negative Charge & Positive Charge.

Tapes: "The Wet Cell", & "Negative Charge", & "Positive Charge".

PROCEDURE:

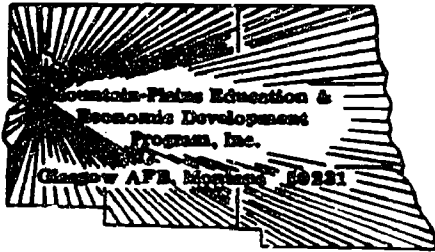
1. View films and listen to tapes in sequence, The Wet Cell, Negative Charge, & Positive Charge.
2. Review the text reference pp. 7-25.
3. Using the floor plan and the resources listed as reference, sketch on the floor plan, the junction boxes necessary to comply with the resource specifications.

NOTE: Make your sketches on the plan neatly and clearly. Follow the procedure presented in the text.

4. When you have completed steps 1-4, compile the requested data on your Performance Activity list.
5. Go to your instructor for evaluation and checkoff. Have the instructor initial your Performance Record in the appropriate space.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

6. Clean up area.
7. Take the test for this LAP.
8. Score the LAP test and return it.
9. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

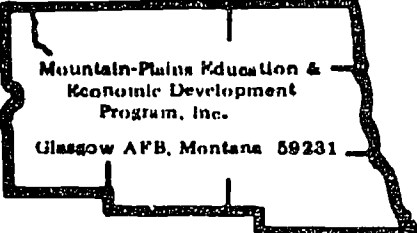
**LAP TEST: LAYING OUT JUNCTION BOXES ON A PLAN**

1. To avoid undue complexity on working drawings, the architect usually provides a set of:
 - a. building plans.
 - b. specifications.
 - c. plat plans.
 - d. sketches.
2. A device mounted in a box is counted as:
 - a. one wire.
 - b. not counted as a wire.
 - c. two wires.
 - d. three wires.
3. Each neutral wire entering and leaving a box is counted as:
 - a. two wires.
 - b. one wire.
 - c. three wires.
 - d. not counted.
4. Where are notations found on a electrical plan?
 - a. on the plan letterhead
 - b. in the specifications
 - c. in the plan margin.
 - d. next to a symbol, usually as abbreviations
5. What size is the opening of a switch box for a single device?
 - a. $1 \frac{3}{4} \times 2 \frac{3}{4}$
 - b. $1 \frac{1}{2} \times 2 \frac{1}{2}$
 - c. $1 \frac{1}{2} \times 3$
 - d. $1 \frac{1}{4} \times 3$
6. Boxes are measured:
 - a. by outside opening.
 - b. by inside opening.
 - c. diagonally.
 - d. by circumference.

7. What are offset bar hangers used for?
 - a. to mount fluorescent lights
 - b. to mount fixtures
 - c. to mount boxes
 - d. to mount power panels
8. The code that establishes the standards for electrical work is:
 - a. UL.
 - b. EBC.
 - c. CEC.
 - d. NEC.
9. What advantage does a 4 inch box have over a 3 1/4 inch octagonal box?
 - a. has less conductor capacity
 - b. easier to mount
 - c. has more conductor capacity
 - d. costs less
10. When counting the number of wires in a box, a wire that originates and terminates within the box is:
 - a. counted as one wire.
 - b. ignored.
 - c. not counted as a wire.
 - d. counted as two wires.

LAP TEST ANSWER KEY: LAYING OUT JUNCTION BOXES ON A PLAN

- | | |
|-----|---|
| 1. | b |
| 2. | a |
| 3. | a |
| 4. | d |
| 5. | a |
| 6. | b |
| 7. | c |
| 8. | d |
| 9. | c |
| 10. | c |



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Program, Inc.
Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Determining the Size of Junction Boxes

OBJECTIVE:

Given a blueprint and specifications, identify and record the type, description, and quantity of all junction boxes on a requisition form. Compiled data must correlate to and conform with the listed references. Identify the procedure for identifying the type and size and quantity of junction boxes from print specifications.

EVALUATION PROCEDURE:

Accurate ordering of the parts and supplies needed to complete the specific job listed in the objective and on the blueprint. Complete, score, and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Supply Catalog.
Electrical Wiring, Ray C, Mullin, pp. 7-25.

PROCEDURE:

1. Obtain an Electrical Parts Supply Catalog.
2. Using the attached requisition and the blueprint sketch you have completed, order the parts and supplies needed to complete the job indicated in the objective.
NOTE: Parts and supplies must be ordered by quantity, complete description and type.
3. Hand in the completed requisition for evaluation along with your blueprint sketch.
4. Complete the requested data on your Performance Record.
5. Have the instructor initial it when you have correctly completed the indicated operation.
6. Clean up area.
7. Take the test for this LAP.
8. Score the LAP test and return it.
9. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

Post Office Box 3078
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PURCHASE REQUISITION

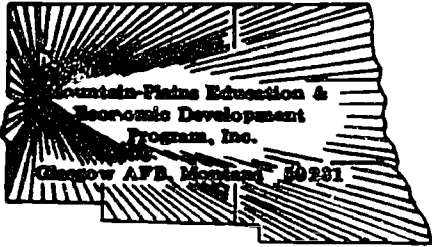
72.01.01.09.A2-0

-ORIGINATOR'S CONTROL NO.-

REQUISITION NO.	REQUISITION DATE	TIME REQUIRED	PURCHASE ORDER NO.	PAGE of
<input type="checkbox"/> RESEARCH DEVELOPMENT <input type="checkbox"/> START UP		<input type="checkbox"/> OPERATIONS	ACCOUNTING DATA	DEPARTMENT
SUGGESTED SOURCE		USING ACTIVITY	<input type="checkbox"/> ADMINISTRATION <input type="checkbox"/> FAMILY LIFE <input type="checkbox"/> INSTRUCTION <input type="checkbox"/> MULTI-PURPOSE <input type="checkbox"/> STATE PROGRAMS <input type="checkbox"/> PLANNING & RESEARCH <input type="checkbox"/> OTHER	
		USED FOR		

ITEM NO.	QUAN.	UNIT	DESCRIPTION OF SUPPLIES / SERVICES	EST. UNIT PRICE	EST. AMOUNT

REMARKS			EST. TOTAL AMOUNT 		
Title	Signature	Date	Title	Signature	Date
ORIGINATOR			PROPERTY CONTROLLER		
DEPT. HEAD			PROCUREMENT OFFICER		
DIRECTOR			ACCOUNTING OFFICE (To Procurement)		

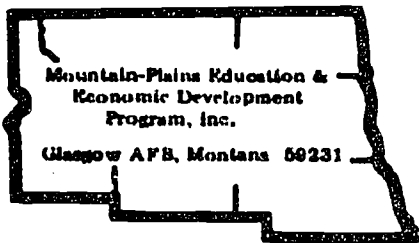
LAP TEST: ~~DETERMINING~~ THE SIZE OF JUNCTION BOXES

1. Where is the attic access found? (See Plans)
 - a. in the bedroom closet
 - b. in the hall between bedrooms
 - c. in the utility room
 - d. in the hall from the garage
2. Each neutral wire entering and leaving a box is counted as:
 - a. one wire.
 - b. not counted.
 - c. two wires.
 - d. three wires.
3. Which of the following phrases is used when a substitution of an item is allowable?
 - a. or equivalent
 - b. equal to
 - c. equivalent with
 - d. equal with
4. When counting the number of wires in a box, a wire that originates and terminates within the box is:
 - a. not counted as a wire.
 - b. counted as two wires.
 - c. counted as one wire.
 - d. ignored.
5. The code that establishes the standards for electrical work is:
 - a. CEC.
 - b. UL.
 - c. NEC.
 - d. EBC.
6. A device mounted in a box is counted as:
 - a. one wire.
 - b. not counted as a wire.
 - c. two wires.
 - d. three wires.

7. What is the size of the studding used in the partition between the bathroom and rear bedroom? (See Plans)
- a. 2 x 2
 - b. 2 x 4
 - c. 2 x 6
 - d. 2 x 3
8. All ground wires entering and leaving a box are counted as:
- a. two wires.
 - b. one wire.
 - c. not counted.
 - d. three wires.
9. How wide, approximately, is the concrete apron (NE to SW)? (See Plans)
- a. 5' 5 1/2"
 - b. 22' 5"
 - c. 20' 0"
 - d. 23' 1 1/2"
10. What is the depth of the garage front to back? Give the measurement to the inside of the studs to 1/4". (See Plans)
- a. 23'
 - b. 22' 2"
 - c. 22' 5"
 - d. 23' 1 1/2"

LAP TEST ANSWER KEY: DETERMINING THE SIZE OF JUNCTION BOXES

1. d
2. c
3. a
4. a
5. c
6. a
7. b
8. b
9. c
10. c



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Installing Junction Boxes

OBJECTIVE:

Given the necessary tools, equipment, and supplies, correctly install junction boxes according to manufacturer's and blueprint specifications; following procedures and practices accepted in the industry and outlined in the reference text. Identify the procedures for installing junction boxes according to specifications.

EVALUATION PROCEDURE:

Meet the criteria listed on the attached checklist. Complete, score, and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray Mullin, pp. 11-25.
Manufacturer's Specifications.

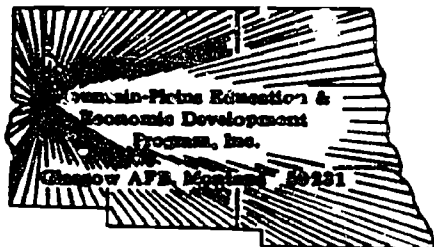
PROCEDURE:

1. Go to your assigned work station. Review the text if necessary.
2. Obtain the necessary tools, equipment, and supplies needed to complete the operations listed.
3. Complete the job listed in the objective.
- NOTE: FOLLOW SAFE PRACTICES AND PROCEDURES.**
4. Perform all necessary testing and evaluation checks listed in the checklist. If you have any questions or problems, check with the instructor.
5. When you have been checked off on the checklist by the instructor, complete the data requested on your Performance Record and have him initial it.
6. Clean up the area.
7. Take the test for this LAP.
8. Score the LAP test and return it.
9. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory proceed as directed by the instructor.

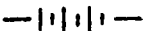







Principal Author(s): R. Arneson, L. Leland, T. Ziller





CHECKLIST: INSTALLING JUNCTION BOXES

- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.



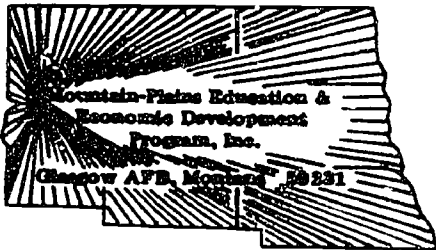
LAP TEST: INSTALLING JUNCTION BOXES

1. What advantage does a 4 inch box have over a 3 1/4 inch octagonal box?
 - a. costs less
 - b. easier to mount
 - c. has more conductor capacity
 - d. has less conductor capacity
2. Which of the following symbols indicates a battery?
 - a. 
 - b. 
 - c. 
 - d. 
3. A device mounted in a box is counted as:
 - a. one wire.
 - b. three wires.
 - c. not counted as a wire.
 - d. two wires.
4. Which of the following symbols indicates a power panel?
 - a. 
 - b. 
 - c. 
 - d. 
5. What is the size opening of a switch box for a single device?
 - a. 1 1/2 x 2 1/2
 - b. 1 3/4 x 2 3/4
 - c. 1 1/2 x 3
 - d. 1 1/4 x 3



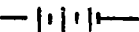









6. What is the size of the building lot? (See Plans)
- 100' x 99'
 - 20' x 201'
 - 199' x 199'
 - 200' x 200'
7. Which of the following symbols indicates a range outlet?
-  R
 -  R
 -  R
 -  R
8. Dash lines on an electrical plan:
- always are used to indicate switch connections.
 - never are used to indicate switch connections.
 - always indicate special purpose use.
 - always are used to connect outlets.
9. Boxes are measured:
- by inside opening.
 - by outside opening.
 - diagonally.
 - by circumference.
10. When counting the number of wires in a box, a wire that originates and terminates within the box is:
- counted as two wires.
 - not counted as a wire.
 - counted as one wire.
 - ignored.

LAP TEST ANSWER KEY: INSTALLING JUNCTION BOXES

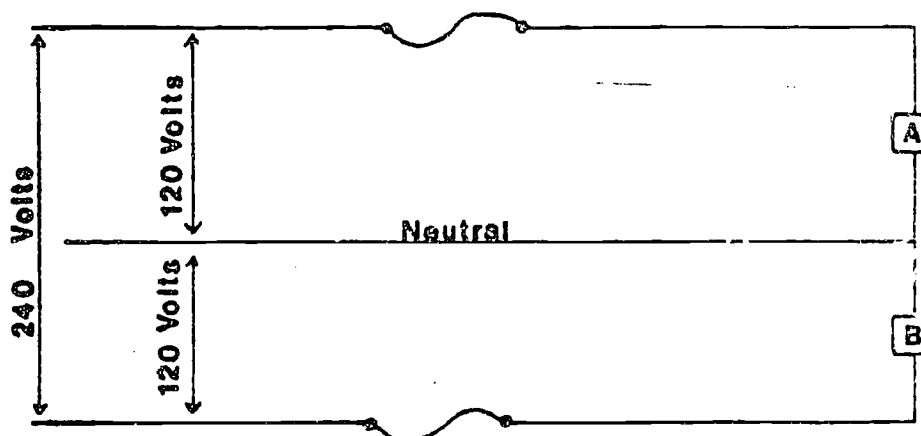
1. c
2. a
3. a
4. b
5. b
6. d
7. c
8. a
9. a
10. b



UNIT POST TEST: OUTLET AND SWITCH BOXES

- 72.01.01.01 1. Which of the following symbols indicates a battery?
-  B
 -  B
 -  B
 -  B
2. What so the initials U/L stand for?
- Underwriters Law
 - Universal Law
 - Underwriters Laboratory
 - University Laboratory
3. The electrical code provides _____ standards.
- equivalent
 - equal
 - minimum
 - maximum
4. Which of the following symbols is a ceiling outlet?
-  B
 -  B
 -  B
 -  B
5. Which of the following symbols indicates a power panel?
-  B
 -  B
 -  B
 -  B

- 72.01.01.02
6. What is the overall length of the building as shown on the plan?
 - a. 20'0"
 - b. 22'1/4"
 - c. 64'5 1/4"
 - d. 24'0"
 7. What is the depth of the garage front to back? Give the measurement to the inside of the studs to a 1/4".
 - a. 23'
 - b. 22'5"
 - c. 22'2"
 - d. 23' 1 1/2"
 8. Each neutral wire entering and leaving a box is counted as:
 - a. not counted.
 - b. one wire.
 - c. two wires.
 - d. three wires.
 9. Where is the attic access found?
 - a. in the hall from the garage
 - b. in the utility room
 - c. in the hall between bedrooms
 - d. in the bedroom closet
 10. How many feet of base board electric heating units are indicated in the living and dining room areas?
 - a. 35'
 - b. 25'
 - c. 45'
 - d. 20'
- 72.01.01.03
11. In a three-wire two-circuit system, if the load on one circuit decreases, the load on the other circuit:
 - a. decreases.
 - b. remains constant.
 - c. fluctuates.
 - d. increases.



In the diagram: Load A is rated at 10 amperes, 120 volts
Load B is rated at 5 amperes, 120 volts

12. When connected to the three-wire circuit as indicated, how much current will flow in the neutral conductor?
 - a. 10 AMPS
 - b. 5 AMPS
 - c. 20 AMPS
 - d. 15 AMPS
 13. If three wires are used to carry two circuits, the grounded or white wire carries:
 - a. all the resistance.
 - b. all the current.
 - c. the balanced current.
 - d. the unbalanced current.
 14. In the diagram if the neutral were to open, what type of circuit would it be?
 - a. parallel/series
 - b. combination
 - c. series
 - d. parallel
 15. In a three wire system which carries two circuits, if one circuit carried 10 AMPS and the other circuit carried 12 AMPS, the neutral ground would carry:
 - a. 2 AMPS.
 - b. 120 AMPS.
 - c. 12 AMPS.
 - d. 22 AMPS.
- 72.01.01.04 16. What are offset for hangers used for?
- a. to mount boxes
 - b. to mount fluorescent lights
 - c. to mount fixtures
 - d. to mount power panels





17. Electrical symbols on a drawing serve what function?

- a. drawings
- b. shorthand notations
- c. sketches
- d. pictures





18. All ground wires entering and leaving a box are counted as:

- a. three wires.
- b. two wires.
- c. one wire.
- d. not counted.

19. Which of the following symbols is a ceiling outlet?

- a. 
- b. 
- c. 
- d. 

20. Which of the following symbols indicates a duplex outlet?

- a. 
- b. 
- c. 
- d. 

72.01.01.05 21. How high above the finish floor are switches usually mounted?

- a. 36" to bottom of box
- b. 65" to bottom of box
- c. 48" to bottom of box
- d. 12" to bottom of box

22. Which of the following phrases is used when a substitution of an item is allowable?

- a. equivalent
- b. equal with
- c. equal to
- d. or equivalent

23. Three switches are to be mounted in a three gang switch box. The wall plate for this location would be called a:

- a. three-gang free plate.
- b. gang plate.
- c. three-gang switch plate.
- d. three-gang wall plate.

24. Where is the attic access found?

- a. in the utility room
- b. in the hall between bedrooms
- c. in the hall from the garage
- d. in the bedroom closet

25. To what material are the front entrance light and the front garage light fastened?

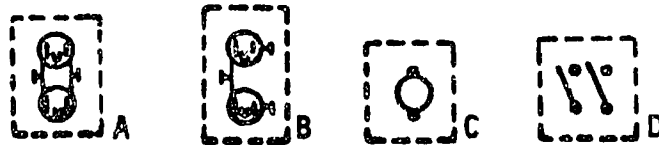
- a. masonite
- b. stone
- c. wood
- d. concrete

72.01.01.06

26. In reference to pendants in closets, the electrical codes states they may:

- a. be used.
- b. be used in certain cases.
- c. not be used.
- d. be installed vertically.

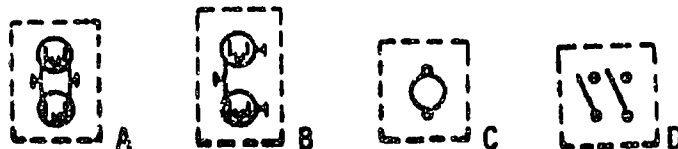
27. Which of the following is a two-gang switch box symbol? *



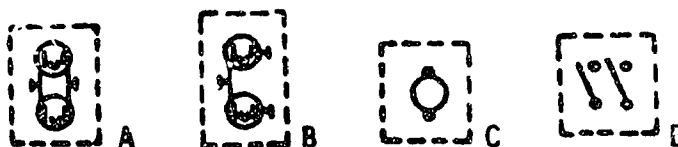
28. For outlets, building plans typically do not specify:

- a. quantity.
- b. amount.
- c. location.
- d. wattage ratings.









29. Which of the following is a ceiling or wall fixture outlet symbol? *



30. Which of the following is a duplex split-circuit convenience receptacle grounding type? *



* (From Electrical Wiring - Residential, Mullin, Delmar Publishers.)

- 72.01.01.07
31. The NEC states that the minimum wire size allowable in a house is which of the following?
 - a. 14 AWG
 - b. 10 AWG
 - c. 12 AWG
 - d. 10 AWG
 32. Which of the following is the symbol for a duplex outlet?
 - a. 
 - b. 
 - c. 
 - d. 
 33. Three switches are to be mounted in a three-gang switch box. The wall plate for this location would be called a:
 - a. three-gang face plate.
 - b. three-gang switch plate.
 - c. gang plate.
 - d. three-gang wall plate.
 34. Each neutral wire entering and leaving a box is counted as:
 - a. three wires.
 - b. two wires.
 - c. one wire.
 - d. not counted.
 35. Which of the following is the symbol for a duplex outlet split circuit?
 - a. 
 - b. 
 - c. 
 - d. 

72.01.01.08

 36. What are offset bar hangers used for?
 - a. to mount fixtures
 - b. to mount boxes
 - c. to mount power panels
 - d. to mount fluorescent lights
 37. Where are notations found on an electrical plan?
 - a. in the specifications
 - b. next to a symbol, usually as abbreviations
 - c. in the plan margin
 - d. on the plan letterhead

38. A device mounted in a box is counted as:
- two wires.
 - not counted as a wire.
 - three wires.
 - one wire.
39. Which of the following phrases is used when a substitution of an item is allowable?
- equivalent with
 - equal with
 - equal to
 - or equivalent
40. All ground wires entering and leaving a box are counted as:
- three wires.
 - not counted.
 - one wire.
 - two wires.
- 72.01.01.09 41. What is the depth of the garage front to back? Give the measurement to the inside of the studs to 1/4". (See Plans)
- 23' 1 1/2"
 - 22' 5"
 - 23'
 - 22' 2"
42. The code that establishes the standards for electrical work is:
- CEC.
 - UL.
 - EBC.
 - NEC.
43. How many feet of baseboard electric heating units are indicated in the living and dining room area? (See Plans)
- 20'
 - 45'
 - 35'
 - 25'
44. To avoid undue complexity on working drawings, the architect usually provides a set of:
- sketches.
 - building plans.
 - plat plans.
 - specifications.

45. How wide, approximately, is the concrete apron (NE to SW)? (See Plans)

- a. 4'8"
- b. 3'6"
- c. 20'0"
- d. 5'5 1/2"

72.01.01.10 46. What is the size of the footing for the lally column in the garage?
(See Plans)

- a. 24" x 12" x 24"
- b. 12" x 24" x 24"
- c. 16" x 24" x 12"
- d. 24" x 24" x 12"

47. Boxes are measured by:

- a. outside opening.
- b. diagonally.
- c. circumference.
- d. inside opening.

48. When counting the number of wires in a box, a wire that originates and terminates within the box is:

- a. counted as two wires.
- b. ignored.
- c. not counted as a wire.
- d. counted as one wire.

49. Dash lines on an electrical plan:

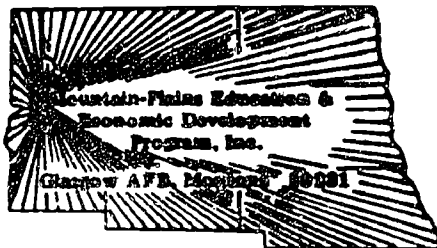
- a. always are used to indicate switch connections.
- b. always are used to connect outlets.
- c. always indicate special purpose use.
- d. never are used to indicate switch connections.

50. A device mounted in a box is counted as:

- a. one wire.
- b. two wires.
- c. three wires.
- d. not counted as a wire.

UNIT POST TEST ANSWER KEY: OUTLET AND SWITCH BOXES

72.01.01.01	1.	c
	2.	c
	3.	c
	4.	a
	5.	a
72.01.01.02	6.	c
	7.	b
	8.	c
	9.	a
	10.	b
72.01.01.03	11.	d
	12.	b
	13.	d
	14.	c
	15.	a
72.01.01.04	16.	a
	17.	b
	18.	c
	19.	d
	20.	c
72.01.01.05	21.	c
	22.	d
	23.	d
	24.	c
	25.	c
72.01.01.06	26.	c
	27.	d
	28.	d
	29.	c
	30.	b
72.01.01.07	31.	a
	32.	c
	33.	d
	34.	b
	35.	c
72.01.01.08	36.	b
	37.	b
	38.	d
	39.	d
	40.	c
72.01.01.09	41.	b
	42.	d
	43.	d
	44.	d
	45.	b
72.01.01.10	46.	d
	47.	d
	48.	c
	49.	a
	50.	a



Family Pay Number: _____ Sex: M F (Circle 1)

UNIT PERFORMANCE TEST: OUTLET AND SWITCH BOXES**OBJECTIVE 1:**

Given a blueprint, the student will make a sketch of an electrical layout to determine quantity and location of outlet and switch boxes.

OBJECTIVE 2:

Given a blueprint, the student will determine and obtain the necessary materials to complete the installation.

OBJECTIVE 3:

The student will properly install outlet, switch and junction boxes according to the National Electrical Code.

TASK:

The student will be given a floor plan of a particular room. He will then sketch the required electrical box installation, obtain tools, equipment, and supplies, and make the required installations as prescribed by the National Electrical Code.

ASSIGNMENT:**CONDITIONS:**

The student will be tested in a wood frame construction to simulate any specified room of a residence. The student will be given necessary tools and equipment. No assistance may be obtained from another student or the instructor or from unspecified text material.

RESOURCES:**Tools:**

- High leverage plier
- High leverage oblique cutting plier
- Long nose cutting plier
- Electrician's hammer
- Screwdriver slot 3/16 x 4
- Screwdriver No. 2 phillips 8"
- Screwdriver slot 3/16 x 9
- Screwdriver 1/4 x 4
- Screwdriver 1/4 x 6
- Nutdriver variable size 1/4" x 7/16
- Scratch awl
- Adjustable wrench size 8"
- Pump plier size 10"
- All-purpose tool, wire stripper, crimper, and cutter
- Tape rule 12' 3/4"
- Knife, electricians
- Tool pouch, 5 pocket

Equipment:

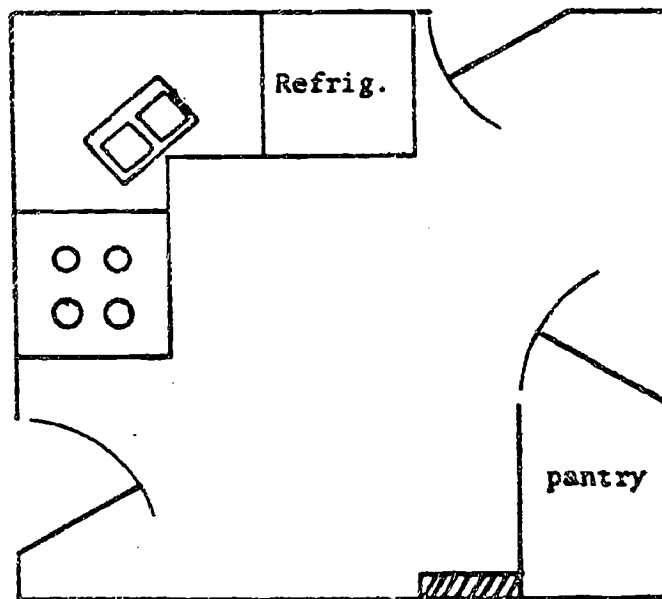
- Simpson 260 VOM or Amprobe

Text:

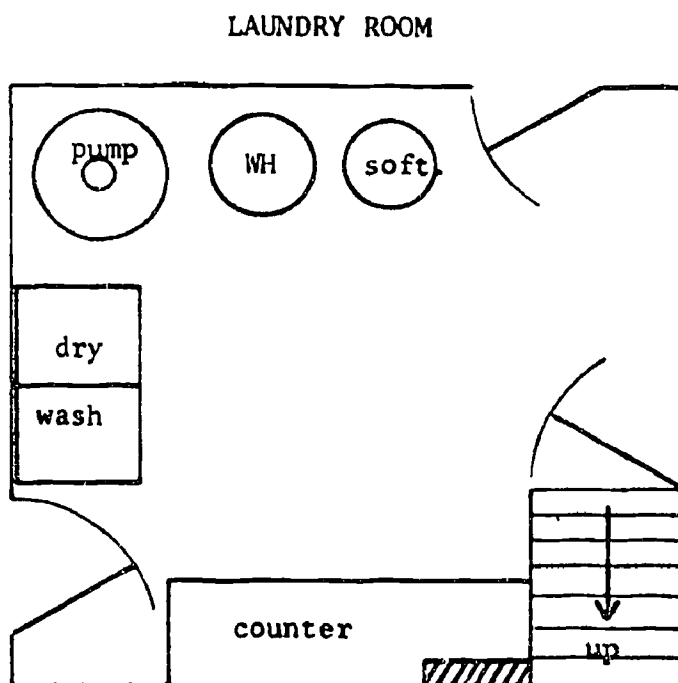
- Electrical Wiring Residential, Ray C. Mullin, Delmar Publisher, 4th Ed., 1973
- National Electrical Code

ASSIGNMENT SHEET 1

KITCHEN



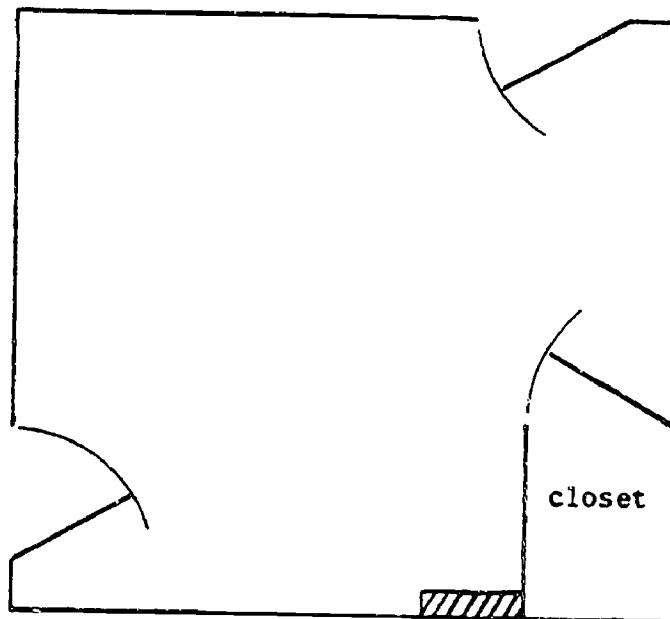
- garbage disposal
- pantry light
- light 2-position control

ASSIGNMENT SHEET 2

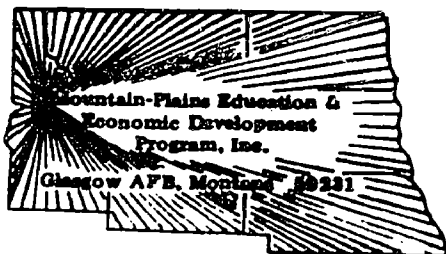
- sub-pump
- water heater
- water softener
- 3-position switch control

ASSIGNMENT SHEET 3

LIVING ROOM



- electric heat
- split receptacles
- 2-position switch control



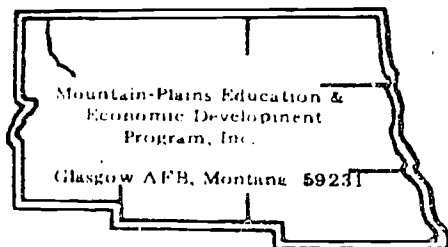
Family Pay Number: _____ Sex: M F (Circle 1)

PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory _____ Unsatisfactory _____

	CRITERION	
	Met	Not Met
Objective 1:		
1. The student properly prepares a sketch of floor plan		
Criterion: Student uses sketch while making the installation		
Objective 2:		
2. The student selects proper outlet boxes		
3. The student selects proper junction boxes		
4. The student selects proper switch boxes		
Criterion: Box selection meets National Electrical Code requirements		
Objective 3:		
5. Switch box location		
6. Junction box location		
7. Outlet box location		
Criterion: Meets National Electrical Code and Blueprint specifications		
8. Switch boxes properly installed		
9. Junction boxes properly installed		

	CRITERION	
	Met	Not Met
10. Outlet boxes properly installed		
Criterion: They must be squared and plumbed		
11. Switch boxes appropriately fastened		
12. Outlet boxes appropriately fastened		
13. Junction boxes appropriately fastened		
Criterion: Remain stable when instructor attempts to dislodge them with hands		
14. The installation is completed in the specified time.		
Criterion: See assignment for time specifications.		
Student must meet criterion on all line items to obtain an overall score of		
satisfactory.		



Learning Experience Guide

UNIT: WIRING

RATIONALE:

The typical tasks for an electrical wireman are layout, determining type and quality of materials, and the installation of various circuits. Skill in installing a variety of electrical cables and tubing is necessary for a qualified wireman. These skills are developed through the activities of this unit.

PREREQUISITES:

Besides the prerequisites for this course you need to master this objective for Unit .01: Outlet and Switch Boxes.

OBJECTIVE:

Identify procedures for sketching, calculating capacity, and installation of electrical circuits. Identify characteristics of electrical conduit given in plan specifications. Given blueprint specifications, National Electrical Codes, tools building or shop simulation, students will sketch layouts, estimate materials required and make installations of wiring as specified for the electrical circuits.

RESOURCES:

Electrical Wiring Residential, Delmar Publisher, 1973.

An assortment of electrical supply catalogs.

An assortment of manufacturer's electrical products specification guide.

Set of electrical wireman's tools.

Electrical Wiring, Ray C. Mullin, pp. 26-44.

Film Loops:

Insulators and Conductors, Fairfield Associates, the Jam Handy Organization.

Liquid Conductors I and II, Fairfield Associates, the Jam Handy Organization.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

The Circuit, Fairfield Associates, the Jam Handy Organization.

Series Circuit, and Parallel Circuit, Fairfield Associates, the Jam Handy Organization.

Electromotive Force, Fairfield Associates, the Jam Handy Organization.

Reversing Polarity, Fairfield Associates, the Jam Handy Organization.

Audio Cassette Tapes.

Narration for each of the film loops listed, Mountain-Plains Education & Economic Development Program, Inc.

GENERAL INSTRUCTIONS:

You have been prescribed into this unit. Each performance activity that will be assigned to you will have a LAP that gives you direction for work. Follow the procedure in the LAP carefully. When finishing this unit, a unit test will be given you. After completing the test, you will be assigned another unit in this course.

PERFORMANCE ACTIVITIES:

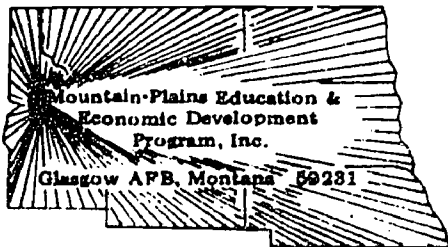
- .01 Laying Out Circuits on a Plan
- .02 Calculating Circuit Capacity
- .03 Installing Ground Fault Circuit Interrupters
- .04 Installing Lighting Circuits
- .05 Installing Special Appliance Circuits
- .06 Installing Individual Appliance Circuits
- .07 Installing Surface EMT
- .08 Installing Armored Cable

EVALUATION PROCEDURE:

Success in this unit is determined by identifying 80% of the desired responses to a set of multiple choice test items and obtaining a "satisfactory" for completing each line item on a performance test.

FOLLOW-THROUGH:

After you have read this unit guide, begin reading the LAP for the first performance activity assigned to you. Use the skills and knowledges acquired to do the activities assigned.



UNIT PRETEST: WIRING

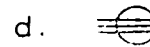
- 72.01.02.01.A2-2 1. Notching the stud cable installation requires _____ in (on) studs.
- NMC cable
 - metal covering
 - AWG cable
 - NM cable
2. The electrical code states that no point in any room shall be more how many feet from a receptacle?
- 8'
 - 4'
 - 6'
 - 10'
3. What is the meaning of computed load?
- sum of ohms in all branch circuits
 - sum of watts in all branch circuits
 - sum of all branch circuit loads
 - sum of volts in all branch circuits
4. What is the minimum size conductor allowable for outlets meant for small appliances?
- 12 AWG
 - 14 AWG
 - 8 AWG
 - 10 AWG
5. When grounding a house, where ever possible it should be grounded to:
- 22' rod.
 - 24' pole.
 - 2' pile aster.
 - 10' pipe.

- 72.01.02.02.A2-2 6. What is the meaning of a computed load?
- sum of ohms in all branch circuits
 - sum of volts in all branch circuits
 - sum of all branch circuit loads
 - sum of watts in all branch circuits
7. The electrical code requires at least what number of outlets for the laundry.
- one
 - three
 - two
 - four
8. What is the unit load per square foot for dwellings?
- 32 volts per sq. ft.
 - 20 watts per sq. ft.
 - 20 amps per sq. ft.
 - 3 watts per sq. ft.
9. The electrical code states that no point in any room shall be more than how many feet from a receptacle?
- 4'
 - 10'
 - 6'
 - 8'
10. When grounding a house, where ever possible it should be grounded to:
- 10' pipe.
 - 24' pole.
 - 22' rod.
 - 2' pile aster.
- 72.01.02.03.A2-2 11. What is the height of the fireplace mantel to the top finish from finish floor? (See PLans)
- | | |
|--------|--------|
| a. 50" | c. 46" |
| b. 52" | d. 48" |
12. What is the width of a two-gang switch plate?
- | | |
|----------------------|-----------------------|
| a. $4 \frac{1}{4}$ " | c. $3 \frac{1}{2}$ " |
| b. $2 \frac{1}{2}$ " | d. $4 \frac{9}{16}$ " |

- 72.01.02.03.A2-2 13. A dimmer switch with an auto transformer controls the lighting circuit:
- amperage.
 - resistance.
 - voltage.
 - current.
14. From how many locations can the cornice lights be controlled (see plan)?
- three
 - one
 - four
 - two
15. How many milli amps will activate a ground fault interrupter?
- 5 milli amps to ground
 - 2 milli amps to ground
 - 4 milli amps to ground
 - 6 milli amps to ground
- 72.01.02.04.A2-2 16. What is the minimum size conductor allowable for outlets meant for small appliances?
- 14 AWG
 - 12 AWG
 - 10 AWG
 - 8 AWG
17. Which of the following abbreviations stands for metal clad cable with plastic insulated conductors?
- ACT
 - MCT
 - MT
 - AT
18. The ampacity of a wire depends on its wire:
- conductor (copper, aluminum).
 - size.
 - make up.
 - length.

- 72.01.02.04.A2-2 19. What is the minimum number of 15 ampere lighting circuits if the dwelling has an occupied area of 4,000 square feet?
- a. 8
 - b. 6
 - c. 9
 - d. 7
20. NMC cable must not be bent in a radius less than _____ its cable diameter.
- a. four times
 - b. three times
 - c. five times
 - d. twice
- 72.01.02.05.A2-2 21. According to the National Electrical Code, at least how many branch circuits must be supplied to a kitchen for small appliances?
- a. three
 - b. four
 - c. two
 - d. one
22. What system is used for the wiring of the receptacles in the kitchen (see plan)?
- a. split circuit
 - b. compound circuit
 - c. standard
 - d. split circuit switched
23. When speaking of fluorescent bulbs, which of the following letters are used to indicate Deluxe Warm White?
- a. WWX
 - b. WWD
 - c. WWDX
 - d. WWFDX
24. How many conductor cables will be required in the kitchen receptacle (small appliance) circuit(s) (see plan)?
- a. four
 - b. three
 - c. one
 - d. two

72.01.02.05.A2-2 25. Which of the following is a symbol for a clock?



72.01.02.06.A2-2 26. The plaster cover of raised cover thickness is dependent upon which of the following:

- a. insulation thickness
- b. finish material
- c. box construction
- d. stud thickness

27. Which of the following is the accepted symbol for chimes?



28. What type of receptacle is used in the recreation room? (See Plans)

- a. split circuit
- b. standard grounding
- c. standard
- d. split circuit switched

29. If conductor count is larger than a box capacity depth, and depth of box is restricted by constructions to $1\frac{1}{2}$ ", which of the following boxes would you choose?

- a. $12 \times 1\frac{1}{2}$ "
- b. $2" \times 2"$
- c. $4 \times 1\frac{1}{2}"$
- d. $2 \times 1\frac{1}{2}"$

30. What is the rating of each receptacle in the utility room? (See Plans)

- a. standard
- b. 15 amp
- c. 20 amp
- d. 30 amp

- 72.01.02.07.A2-2 31. In what type of material is the S₃ mounted at the bottom of the rear steps (see plan)?
- horizontal wood siding
 - vertical wood siding
 - stone
 - concrete
32. What are the walls and ceilings of the garage lined with (see plan)?
- 3/8" sheet rock
 - 3/16" sheet rock
 - 1/2" rock
 - 3/16" flex board
33. A circuit that is controlled from three (3) locations requires one of the following switches. Which one?
- three way
 - four way
 - single pole
 - double pole
34. How many wires enter the NW ceiling outlet in the garage? (See Plans)
- three
 - four
 - one
 - two
35. What size conduit is required between the post light and the garage (see plan)?
- 1"
 - 1/2"
 - 5/8"
 - 3/4"
- 72.01.02.08.A2-2 36. What size conduit would be needed for (5 No. 12 AWG) assuming it is new work and insulated cable is used (see code book)?
- 1 1/4"
 - 1/2"
 - 1"
 - 3/4"

- 71.02.02.08.A2-2 37. What is the maximum ampacity of a RHH conductor installed in conduit in an area of 95° F. (see code book 310-12 through 15) (rating of conductor is 100 amps)?
- a. 75 amps
 - b. 98 amps
 - c. 88 amps
 - d. 96 amps
38. When determining conduit size, what is the percentage of fill if more than 2 conductors are to be installed?
- a. 20%
 - b. 40%
 - c. 60%
 - d. 80%
39. Which of the following is the same as EMT?
- a. thin wall tubing
 - b. rigid tubing
 - c. armored cable
 - d. elec/tromotive/tubing
40. What size conduit would be needed for 3 No. 14 AWC assuming it is new work and insulated cable is used (see code book)?
- a. 3/4"
 - b. 1 1/4"
 - c. 1/2"
 - d. 1"

UNIT PRETEST ANSWER KEY: WIRING

LAP 01

1. b
2. c
3. c
4. a
5. d

LAP 02

6. c
7. a
8. d
9. c
10. a

LAP 03

11. d
12. d
13. c
14. d
15. a

LAP 04

16. b
17. b
18. b
19. c
20. c

LAP 05

21. c
22. a
23. a
24. b
25. c

LAP 06

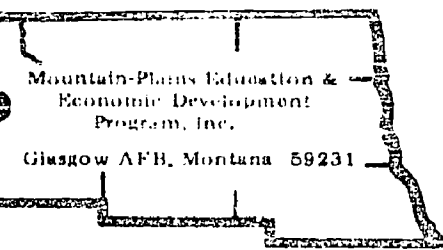
26. b
27. b
28. b
29. c
30. c

LAP 07

31. c
32. d
33. b
34. d
35. d

LAP 08

36. b
37. c
38. b
39. a
40. c



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Laying Out Circuits on a Plan

OBJECTIVE:

Given the necessary tools, equipment, materials, supplies, and a floor plan, sketch in and label all electrical circuits. Sketch must be complete with information and standards identified in the resource text. Identify the procedures for sketching electrical circuits for a given floor plan and recognize the electrical standards that apply.

EVALUATION PROCEDURE:

Accurate completion of the sketch to the standards described in the text. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray C. Mullin, pp. 26-44.

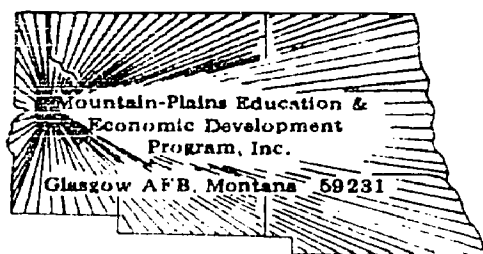
Film: Insulators and Conductors.

Tape: Insulators and Conductors.

PROCEDURE:

1. View film while listening to tape, Insulators and Conductors.
2. Read the text reference, pp. 26-44.
3. Answer the questions on pp. 31-33, 42-44.
4. Using the floor plan (obtain from the instructor) and the resources listed as reference, sketch on the floor plan the electrical circuits necessary to comply with the resource specifications.
NOTE: Make your sketches on the plan neat and clear. Follow the procedure presented in the text.
5. When you have completed steps 1-5 compile the requested data on your Performance Record.
6. Clean up area.
7. Take the test for this LAP.
8. Score the LAP test and return it.
9. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

Principal Author(s): R. Arneson, L. Leland, T. Ziller



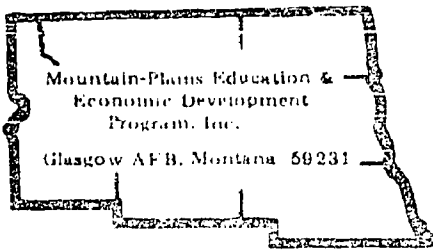
LAP TEST: LAYING OUT CIRCUITS ON PLAN

1. The color code for 3 wire nonmetallic cable is:
 - a. yellow-black-white.
 - b. black-orange-red.
 - c. white-black-red.
 - d. black-white-green.
2. The electrical codes specifies the minimum AWG wire size allowable in a house for lighting and circuits as:
 - a. 14 AWG.
 - b. 18 AWG.
 - c. 16 AWG.
 - d. 12 AWG.
3. NMC cable must not be bent in a radius less than _____ its cable diameter.
 - a. three times
 - b. five times
 - c. twice
 - d. four times
4. The color code for four (4) wire metal clad cable is:
 - a. black-white-red-green.
 - b. black-white-red-yellow.
 - c. black-white-red-blue.
 - d. black-white-red-orange.
5. What is the meaning of computed load?
 - a. sum of ohms in all branch circuits
 - b. sum of watts in all branch circuits
 - c. sum of volts in all branch circuits
 - d. sum of all branch circuit loads

6. Nonmetallic sheathed cable may be installed:
 - a. outside.
 - b. in damp places.
 - c. concealed & exposed.
 - d. inside.
7. According to the electrical code, in the kitchen-dining area, a receptacle must be placed at each:
 - a. lazy susan.
 - b. counter.
 - c. window.
 - d. cabinet.
8. The electrical code states that no point in any room shall be more than how many feet from a receptacle?
 - a. 10'
 - b. 4'
 - c. 6'
 - d. 8'
9. NMC cable must be strapped or stapled not more than how many feet from a box or fitting?
 - a. 16"
 - b. 18"
 - c. 12"
 - d. 14"
10. With the exception of bell wiring & fixture wiring, the insulation of most typical house wire is rated at:
 - a. 400 volts.
 - b. 800 volts.
 - c. 200 volts.
 - d. 600 volts.

LAP TEST ANSWER KEY: LAYING OUT CIRCUITS ON PLAN

1. c
2. a
3. b
4. c
5. d
6. c
7. b
8. c
9. c
10. d



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Calculating Circuit Capacity

OBJECTIVE:

Given a blueprint and specifications, identify and record the type, description, and quantity of materials needed for the electrical circuits listed on a plan. Compiled data must correlate to and conform with the listed references. Identify the procedure for calculation of circuit capacity and recognize the minimum electrical standards that apply.

EVALUATION PROCEDURE:

Accurate ordering of the parts and supplies needed to complete the specific job listed in the objective and on the blueprint. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Supply Catalog.
 Electrical Wiring, Ray C. Mullin, pp. 26-44.
 Film: Liquid Conductors I and II.
 Tape: "Liquid Conductors I and II".

PROCEDURE:

1. View films while listening to tape, "Liquid Conductors I and II".
2. Obtain an Electrical Parts Supply Catalog.
3. Using the attached requisition and the blueprint sketch you have completed, order the parts and supplies needed to complete the job indicated in the objective.
 NOTE: Parts and supplies must be ordered by quantity, complete description and type.
4. Check your requisition with the answer key.
5. Enter the requested data on your Performance Record.
6. Clean up area.
7. Take the test for this LAP.
8. Score the LAP test and return it.
9. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

Principal Author(s): R. Arneson, L. Leland, T. Siller

Post Office Box 3078
Glasgow AFB, Montana 59231

ORIGINATOR'S CONTROL NO.

REQUISITION NO. REQUISITION DATE TIME REQUIRED PURCHASE ORDER NO. PAGE of

☐ RESEARCH DEVELOPMENT ☐ OPERATIONS
☐ START UP

ACCOUNTING DATA

DEPARTMENT

SUGGESTED SOURCE

USING ACTIVITY

☐ ADMINISTRATION
☐ FAMILY LIFE
☐ INSTRUCTION
☐ MULTI-PURPOSE
☐ STATE PROGRAMS
☐ PLANNING & RESEARCH
☐ OTHER

USED FOR

EM O.	QUAN.	UNIT	DESCRIPTION OF SUPPLIES / SERVICES	EST. UNIT PRICE	EST. AMOUNT

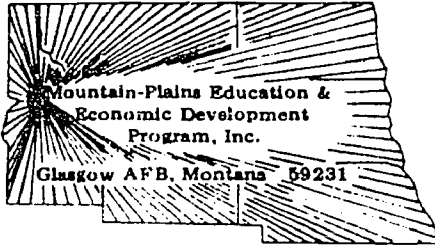
REMARKS

EST. TOTAL
AMOUNT

Title	Signature	Date	Title	Signature	Date
ORIGINATOR			PROPERTY CONTROLLER		
DEPT. HEAD			PROCUREMENT OFFICER		
DIRECTOR			ACCOUNTING OFFICE (To Procurement)		

PROCUREMENT

MPEDOP Form PR-1 3806 REV.



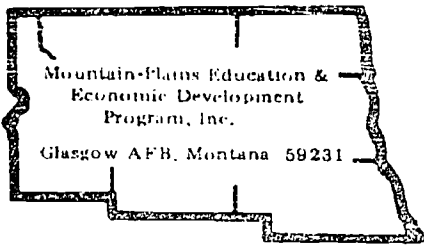
LAP TEST: CALCULATING CIRCUIT CAPACITY

1. When stapling NM cable, the intervals must not exceed:
 - a. 2'.
 - b. 3' 6".
 - c. 5'.
 - d. 4' 6".
2. The ampacity of a wire depends on its wire:
 - a. length.
 - b. size.
 - c. conductor (copper, aluminum).
 - d. make up.
3. According to the electrical code, in the kitchen and dining area a receptacle must be placed at each:
 - a. lazy susan.
 - b. cabinet.
 - c. window.
 - d. counter.
4. What is the minimum number of 15 ampere lighting circuits if the dwelling has an occupied area of 4,000 square feet?
 - a. 7
 - b. 9
 - c. 8
 - d. 6
5. The color code for 3 wire nonmetallic cable is:
 - a. white-black-red.
 - b. black-orange-red.
 - c. yellow-black-white.
 - d. black-white-green.

6. Which of the following abbreviations stands for metal clad cable with plastic insulated conductors?
- a. AC
 - b. MT
 - c. ACT
 - d. MCT
7. What is the meaning of computed load?
- a. sum of ohms in all branch circuits
 - b. sum of watts in all branch circuits
 - c. sum of volts in all branch circuits
 - d. sum of all branch circuit loads
8. When grounding a house, where ever possible it should be grounded to:
- a. 2' pile aster.
 - b. 22' rod.
 - c. 10' pipe.
 - d. 24' pole.
9. What is the unit load per square foot for dwellings?
- a. 3 watts per sq. ft.
 - b. volts per sq. ft.
 - c. 20 amps per sq. ft.
 - d. 20 watts per sq. ft.
10. Floor receptacles are not considered part of the required number of outlets unless they are:
- a. placed near a light switch.
 - b. placed near the wall.
 - c. placed near an appliance.
 - d. placed near a door.

LAP TEST ANSWER KEY: CALCULATING CIRCUIT CAPACITY

1. d
2. b
3. d
4. a
5. a
6. d
7. d
8. c
9. a
10. b



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Installing Ground Fault Circuit Interrupters

OBJECTIVE:

Given the necessary tools, equipment, supplies and blueprint, correctly install a ground fault circuit interrupter according to manufacturer's and blueprint specifications; following procedures and practices accepted in the industry and outlined in the reference text. Recognize the related information and procedures for installation of ground fault circuit interrupters as specified.

EVALUATION PROCEDURE:

Installation meets the criteria listed on the attached checklist. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray Mullin, pp. 111-121.
 Manufacturer's Specifications.
 Film: The Circuit.
 Tape: "The Circuit".

PROCEDURE:

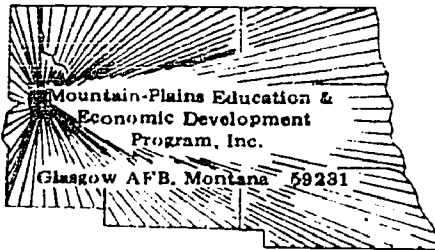
1. View film while listening to tape, "The Circuit".
 2. Read in the resource, pp. 111-121 and answer review questions, pp. 119-121.
 3. Go to your assigned work station where you will complete the activities listed in the objective.
 4. Obtain the necessary tools, equipment and supplies needed to complete the operations listed.
 5. Complete the job listed in the objective.
- NOTE:** FOLLOW SAFE PRACTICES AND PROCEDURES.
6. Perform all necessary testing and evaluation checks listed in the checklist. If you have any questions or problems, check with the instructor.
 7. When you have been checked off on the checklist by the instructor, complete the data requested on your Performance Record.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

8. Clean up the area.
9. Take the test for this LAP.
10. Score the LAP test and return it.
11. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

CHECKLIST: INSTALLING A GROUND FAULT CIRCUIT INTERRUPTER

- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.



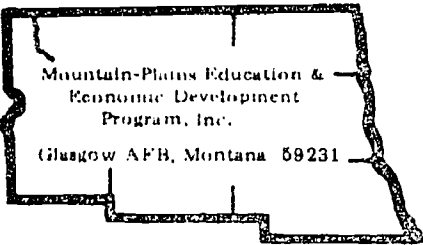
LAP TEST: INSTALLING GROUND FAULT CIRCUIT INTERRUPTERS

1. From how many locations can the cornice lights be controlled (see plan)?
 - a. two
 - b. four
 - c. three
 - d. one
2. When does the code require special protection of cables run in the attics of houses?
 - a. when access hole is provided
 - b. when stairs are provided
 - c. when outside access hole is provided
 - d. when no access hole is provided
3. When a GFR is installed in the main feeder of a power panel, it monitors what?
 - a. the convenience receptacles
 - b. all panel circuits
 - c. the single branch circuit
 - d. the grounding circuit
4. How close can outdoor receptacles be located to a swimming pool?
 - a. 10'
 - b. 30'
 - c. 40'
 - d. 20'
5. What precaution must be taken when installing a multioutlet assembly through a partition?
 - a. conduit in the partition
 - b. no outlet in the partition
 - c. act in the partition
 - d. attach a ground fault interrupter

6. What is the height of the fireplace mantel to the top finish from finish floor? (See Plans)
 - a. 50"
 - b. 52"
 - c. 48"
 - d. 46"
7. When a GFI (ground fault interrupter) is part of the convenience device, it monitors the current supply in what?
 - a. the circuit
 - b. the branch circuit
 - c. the main feeder
 - d. the receptacle
8. How many milli amps will activate a ground fault interrupter?
 - a. 6 milli amps to ground
 - b. 4 milli amps to ground
 - c. 5 milli amps to ground
 - d. 2 milli amps to ground
9. When do circuits serving outdoor receptacles require a ground fault interrupter?
 - a. at all times
 - b. in weather protected areas
 - c. in damp location
 - d. in wet location
10. In what circuits may electronic solid state dimmers be installed?
 - a. fluorescent
 - b. Incandescent
 - c. both
 - d. all lighting circuits

LAP TEST ANSWER KEY: INSTALLING GROUND FAULT CIRCUIT INTERRUPTERS

1. a
2. b
3. b
4. a
5. b
6. c
7. d
8. c
9. a
10. b



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Installing Lighting Circuits

OBJECTIVE:

Given the necessary tools, equipment, supplies and blueprint, correctly install lighting circuits according to manufacturer's and blueprint specifications; following procedures and practices accepted in the industry and outlined in the reference text. Identify the procedure for installation of lighting circuits as specified and recognize related information for such installation.

EVALUATION PROCEDURE:

Installation meets the criteria listed on the attached checklist. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray Mullin, pp. 26-33.
Manufacturer's Specifications.

PROCEDURE:

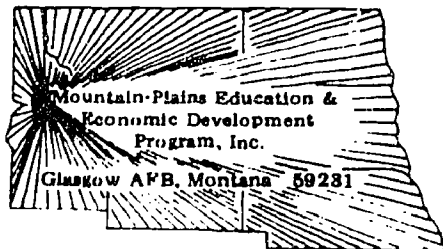
1. Read the resource, pp. 26-33 and answer the questions, pp. 31-33.
2. Go to your assigned work station where you will complete the activities listed in the objective.
3. Obtain the necessary tools, equipment and supplies needed to complete the operations listed.
4. Complete the job listed in the objective.
NOTE: FOLLOW SAFE PRACTICES AND PROCEDURES.
5. Perform all necessary testing and evaluation checks listed in the checklist. If you have any questions or problems, check with the instructor.
6. When you have been checked off on the checklist by the instructor, complete the data requested on your Performance Record and have him initial it.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

7. Clean up the area.
8. Take the test for this LAP.
9. Score the LAP test and return it.
10. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

CHECKLIST: INSTALLING LIGHTING CIRCUITS

- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.



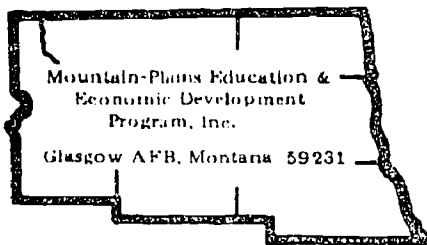
LAP TEST: INSTALLING LIGHTING CIRCUITS

1. NMC cable must not be bent in a radius less than _____ its cable diameter.
 - a. four times
 - b. three times
 - c. five times
 - d. twice
2. A mill is defined as:
 - a. .001.
 - b. .1.
 - c. .01.
 - d. .0001.
3. What is the unit load per square foot for dwellings?
 - a. 200 watts per sq. ft.
 - b. 3 volts per sq. ft.
 - c. 3 watts per sq. ft.
 - d. 20 amps per sq. ft.
4. When grounding a house, where ever possible it should be grounded to:
 - a. 4' pole.
 - b. 22' rod.
 - c. 10' pipe.
 - d. 2' pile aster.
5. What is the meaning of computed load?
 - a. sum of volts in all branch circuits
 - b. sum of ohms in all branch circuits
 - c. sum of all branch circuit loads
 - d. sum of watts in all branch circuits

6. With the exception of bell wiring and fixture wiring the insulation of most typical house wire is rated at:
- a. 600 volts.
 - b. 400 volts.
 - c. 200 volts.
 - d. 800 volts.
7. The ampacity of a wire depends on its wire:
- a. size.
 - b. length.
 - c. conductor (copper, aluminum).
 - d. make up.
8. Nonmetallic sheathed cable may be installed:
- a. in concealed and exposed places.
 - b. inside.
 - c. in damp places.
 - d. outside.
9. Floor receptacles are not considered part of the required number of outlets unless they are:
- a. placed near a door.
 - b. placed near an appliance.
 - c. placed near a light switch.
 - d. placed near the wall.
20. What is the difference between type AC and ACT cable?
- a. conductor use
 - b. its conductor size
 - c. conductor make up
 - d. insulation

LAP TEST ANSWER KEY: INSTALLING LIGHTING CIRCUITS

1. c
2. a
3. c
4. c
5. c
6. a
7. a
8. a
9. d
10. d



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Installing Special Appliance Circuits

OBJECTIVE:

Given the necessary tools, equipment, supplies and blueprint, correctly install special appliance circuits according to manufacturer's and blueprint specifications; following procedures and practices accepted in the industry and outlined in the reference text. Identify related information and procedures for installation of special appliance circuits as specified on the print.

EVALUATION PROCEDURE:

Installation meets the criteria listed on the attached checklist. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray Mullin, pp. 88-97.

Manufacturer's Specifications.

Film: Series Circuit and Parallel Circuit.

Tape: "Series Circuit", and "Parallel Circuit".

PROCEDURE:

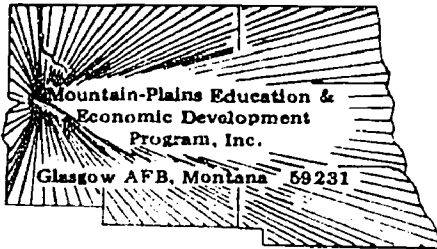
1. View films and listen to tapes, Series Circuit, and Parallel Circuit.
2. Read the resource, pp. 88-97 and answer the questions on pp. 95-97.
3. Go to your assigned work station where you will complete the activities listed in the objective.
4. Obtain the necessary tools, equipment and supplies needed to complete the operations listed.
5. Complete the job listed in the objective.
NOTE: FOLLOW SAFE PRACTICES AND PROCEDURES.
6. Perform all necessary testing and evaluation checks listed in the checklist. If you have any questions or problems, check with the instructor.
7. When you have been checked off on the checklist by the instructor, complete the data requested on your Performance Record and have him initial it.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

8. Clean up the area.
9. Take the test for this LAP.
10. Score the LAP test and return it.
11. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

CHECKLIST: INSTALLING SPECIAL APPLIANCE CIRCUITS

- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.



LAP TEST: INSTALLING SPECIAL APPLIANCE CIRCUITS


1. A three-wire 115-230 volt branch circuit is the equivalent of how many small appliance branch circuits?
 - a. ~~two~~
 - b. three
 - c. one
 - d. four
2. A three-wire 115-230 volt branch circuit is the equivalent of how many receptacle circuits (11SU)?
 - a. four
 - b. one
 - c. three
 - d. two
3. What system is used for the wiring of the receptacles in the kitchen (see plan)?
 - a. split circuit switched
 - b. compound circuit
 - c. standard
 - d. split circuit
4. In a circuit with a breaker of 15 amps 110/120 volts, what is the total wattage allowable for this circuit (approximately)?
 - a. 1440 watts
 - b. 1540 watts
 - c. 1240 watts
 - d. 1040 watts
5. How many built-in appliances are there in the kitchen (see plan)?
 - a. two
 - b. four
 - c. eight
 - d. six

6. Which of the following is a symbol for a clock?

a. 

c. 

b. 

d. 

7. How many conductor cables will be required in the kitchen receptacle (small appliance) circuit(s) (see plan)?

a. three

b. four

c. one

d. two

8. Where is the speed control switch for the fan located in the kitchen (see plan)?

a. part of the stove

b. part of the range

c. right over the counter top

d. part of the fan

9. According to the National Electrical Code, at least how many branch circuits must be supplied to a kitchen for small appliances?

a. one

b. three

c. two

d. four

10. When speaking of fluorescent bulbs, which of the following letters are used to indicate Deluxe Warm White?

a. WWX

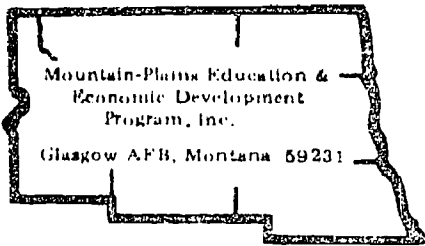
b. WWD

c. WWFDX

d. WWDX

LAP TEST ANSWER KEY: INSTALLING SPECIAL APPLIANCE CIRCUITS

1. a
2. d
3. d
4. a
5. b
6. b
7. a
8. d
9. c
10. a



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Installing Individual Appliance Circuits

OBJECTIVE:

Given the necessary tools, equipment and supplies, correctly install individual appliance circuits according to manufacturer's and blueprint specifications; following procedures and practices accepted in the industry and outlined in the reference text. Identify related information and procedures for installation of individual appliance circuits.

EVALUATION PROCEDURE:

Installation meets the criteria listed on the attached checklist. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray Mullin, pp. 127-135.

Manufacturer's Specifications.

Film: Electromotive Force.

Tape: "Electromotive Force".

PROCEDURE:

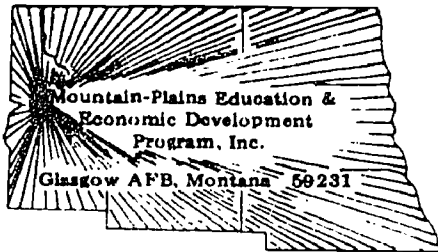
1. View film and listen to tape, Electromotive Force.
2. Read the resource, pp. 127-135 and answer the question on pp. 132-135.
3. Go to your assigned work station where you will complete the activities listed in the objective.
4. Obtain the necessary tools, equipment and supplies needed to complete the operations listed.
5. Complete the job listed in the objective.
NOTE: FOLLOW SAFE PRACTICES AND PROCEDURES.
6. Perform all necessary testing and evaluation checks listed in the checklist. If you have any questions or problems, check with the instructor.
7. When you have been checked off on the checklist by the instructor, complete the data requested on your Performance Record and have him initial it.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

8. Clean up the area.
9. Take the test for this LAP.
10. Score the LAP test and return it.
11. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

CHECKLIST: INSTALLING INDIVIDUAL APPLIANCE CIRCUITS

- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.



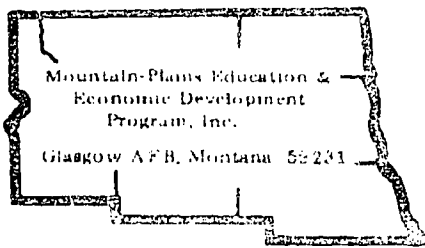
LAP TEST: INSTALLING INDIVIDUAL APPLIANCE CIRCUITS

1. According to the code the receptacles on the terrace must be which of the following (see plan)?
 - a. standard
 - b. recessed
 - c. grounding
 - d. grounding up
2. What type of receptacles are used in the recreation room (see plan)?
 - a. split circuit
 - b. split circuit switched
 - c. standard
 - d. standard grounding
3. Where is the fan mounted? (See Plans)
 - a. between washer and dryer
 - b. on NE utility room wall
 - c. between joists
 - d. between studs
4. What is the rating of each receptacle in the utility room (see plan)?
 - a. standard
 - b. 30 amp
 - c. 15 amp
 - d. 20 amp
5. How many wires would be in a box that has a 13/36 terminating in a ceiling light fixture box?
 - a. 6
 - b. 5
 - c. 2
 - d. 3

6. If a grounding wire enters and leaves a box, it is counted as how many wires?
- four
 - two
 - three
 - one
7. How many wires is the fixture in a ceiling counted as?
- zero
 - two
 - one
 - three
8. If conductor count is larger than a box capacity depth, and depth of box is restricted by constrictions to $1\frac{1}{2}$ ", which of the following boxes would you choose?
- 2" x 2"
 - 4" x $1\frac{1}{2}$ "
 - 2" x $1\frac{1}{2}$ "
 - 12" x $1\frac{1}{2}$ "
9. The freezer receptacle in the utility room is hooked to which circuit in panel B?
(See Plans)
- 8
 - 7
 - 6
 - 9
10. How many receptacles are on the circuit that the freezer in the utility room is plugged into? (See Plans)
- two
 - three
 - one
 - four

LAP TEST ANSWER KEY: INSTALLING INDIVIDUAL APPLIANCE CIRCUITS

1. c
2. d
3. c
4. d
5. b
6. d
7. c
8. b
9. a
10. c



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Installing Surface EMT

OBJECTIVE:

Given the necessary tools, equipment, and supplies, correctly install a surface EMT circuit according to manufacturer's and blueprint specifications; following procedures and practices accepted in the industry and outlined in the reference text. Identify the characteristics of surface (EMT) that are related to installation. Recognize the procedures for installing surface EMT as given on plan specifications.

EVALUATION PROCEDURE:

Installation meets the criteria listed on the attached checklist. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray Mullin, pp. 122-126.

Manufacturer's Specifications.

Film: Reversing Polarity.

Tape: "Reversing Polarity".

PROCEDURE:

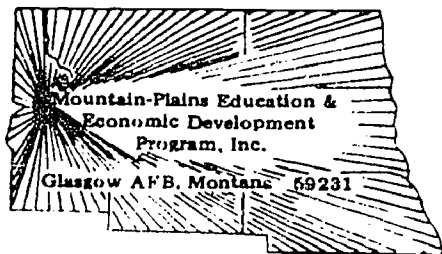
1. View film while listening to tape, Reversing Polarity.
 2. Read the resource, pp. 122-126 and answer the questions on pp. 124-126.
 3. Go to your assigned work station where you will complete the activities listed in the objective.
 4. Obtain the necessary tools, equipment and supplies needed to complete the operations listed.
 5. Complete the job listed in the objective.
- NOTE: FOLLOW SAFE PRACTICES AND PROCEDURES.
6. Perform all necessary testing and evaluation checks listed in the checklist. If you have any questions or problems, check with the instructor.
 7. When you have been checked off on the checklist by the instructor, complete the data requested on your Performance Record and have him initial it.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

8. Clean up the area.
9. Take the test for this LAP.
10. Score the LAP test and return it.
11. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory proceed as directed by the instructor.

CHECKLIST: INSTALLING SURFACE EMT

- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.



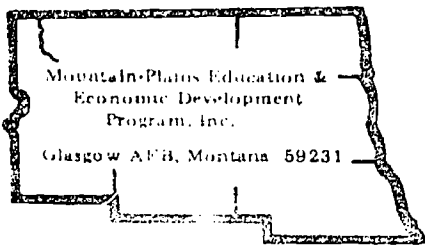
LAP TEST: INSTALLING SURFACE EMT

1. What is the recommended number of lighting fixtures for a one-car garage?
 - a. two
 - b. four
 - c. one
 - d. three
2. What is the recommended number of lighting fixtures for a two-car garage?
 - a. three
 - b. four
 - c. two
 - d. one
3. What are the walls and ceilings of the garage lined with (see plan)?
 - a. 1/2" rock
 - b. 3/8" sheet rock
 - c. 3/16" sheet rock
 - d. 3/16" flex board
4. A circuit that is controlled from three (3) locations requires one of the following switches. Which one?
 - a. three way
 - b. four way
 - c. single pole
 - d. double pole
5. It is only acceptable to use a water pipe which is close to a receptacle as a grounding device. When it is:
 - a. in dry locations.
 - b. in new structures.
 - c. in existing structures.
 - d. in remodeling.

6. The outdoor convenience receptacle on the northwest side of the garage is mounted in what (see plan)?
 - a. stone
 - b. vertical wood siding
 - c. horizontal wood siding
 - d. concrete
7. Which of the following is the garage floor (see plan)?
 - a. level with the kitchen floor
 - b. $7\frac{1}{2}$ " lower than the kitchen floor
 - c. 15" lower than the kitchen floor
 - d. 5" higher than the kitchen floor
8. Which section on the plan shows what the garage is lined with (see plan)?
 - a. A-A
 - b. B-B
 - c. D-D
 - d. E-E
9. A garage that has a floor below grade level is considered by the code as what type of location?
 - a. hazardous
 - b. indefinite
 - c. residential
 - d. nonhazardous
10. What size conduit is required between the post light and the garage (see plan)?
 - a. 1"
 - b. $\frac{3}{4}$ "
 - c. $\frac{5}{8}$ "
 - d. $\frac{1}{2}$ "

LAP TEST ANSWER KEY: INSTALLING SURFACE EMT

1. a
2. a
3. d
4. b
5. c
6. c
7. c
8. d
9. a
10. b



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Installing Armored Cable

OBJECTIVE:

Given the necessary tools, equipment, and supplies, correctly install an armored cable circuit according to manufacturer's and blueprint specifications; following procedures and practices accepted in the industry and outlined in the reference text. Recognize the characteristics of armored cable that are related to installation. Identify the procedures for armored cable installation in accordance with specifications.

EVALUATION PROCEDURE:

Installation meets the criteria listed on the attached checklist. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray Mullin, pp. 136-143.
Manufacturer's Specifications.

PROCEDURE:

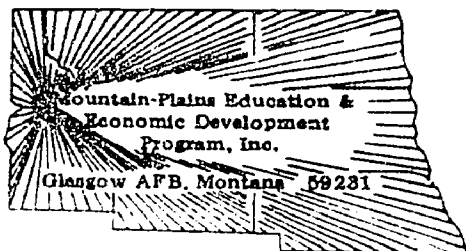
1. Read the resource, pp. 136-143 and answer the questions on pp. 141-143.
2. Go to your assigned work station where you will complete the activities listed in the objective.
3. Obtain the necessary tools, equipment and supplies needed to complete the operations listed.
4. Complete the job listed in the objective.
NOTE: FOLLOW SAFE PRACTICES AND PROCEDURES.
5. Perform all necessary testing and evaluation checks listed in the checklist. If you have any questions or problems, check with the instructor.
6. When you have been checked off on the checklist by the instructor, complete the data requested on your Performance Record and have him initial it.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

7. Clean up area.
8. Take the test for this LAP.
9. Score the LAP test and return it.
10. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

CHECKLIST: INSTALLING AN ARMORED CABLE

- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.



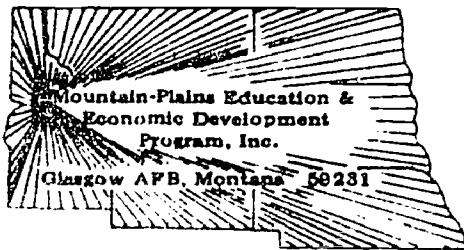
LAP TEST: INSTALLING ARMORED CABLE

1. How many circuits supply the convenience outlets in the workshop (see plan)?
 - a. three
 - b. four
 - c. two
 - d. one
2. On what type of surface is the wall box for the storage room mounted?
 - a. concrete block
 - b. cinder block
 - c. concrete
 - d. panaling
3. When determining conduit size, what is the percentage of fill if more than 2 conductors are to be installed?
 - a. 80%
 - b. 20%
 - c. 40%
 - d. 60%
4. How many wires are counted in a conduit with three wires carrying two circuits 180 out of phase from each other?
 - a. two
 - b. five
 - c. three
 - d. four
5. What size conduit would be needed for 3 No. 12 awg assuming it is new work and insulated cable is used (see code book)?
 - a. 3/4"
 - b. 1/2"
 - c. 1"
 - d. 1 1/4"

6. The code requires which of the following in unfinished basements?
 - a. NMC
 - b. UF
 - c. ACT
 - d. NM
7. Which of the following is the same as EMT?
 - a. thin wall tubing
 - b. armored cable
 - c. elec/tromotive/tubing
 - d. rigid tubing
8. Using the code book 370-6 (A_x1), what size box would be required for 5 No. 14 AWC conductors?
 - a. 4 x 1 1/2 octagonal
 - b. 4 x 2 1/8 octagonal
 - c. 3 1/4 x 1 1/2 octagonal
 - d. 3 1/2 x 1 1/2 octagonal
9. Which of the following requires EMT?
 - a. concealed wiring
 - b. exposed wiring
 - c. wiring in joist
 - d. wiring in studs
10. What is the grounding source in the workshop that should be used (see plan)?
 - a. concrete block
 - b. EMT
 - c. water pipe
 - d. conductor

LAP TEST ANSWER KEY: INSTALLING ARMORED CABLE

1. d
2. b
3. c
4. c
5. b
6. c
7. a
8. c
9. b
10. c



UNIT POST TEST: WIRING

- 2.01.02.01.A2-2 1. The color code for 3 wire nonmetallic cable is:
- black-white-green
 - black-orange-red
 - white-black-red
 - yellow-black-white
2. Floor receptacles are not considered part of the required number of outlets unless they are:
- placed near a door.
 - placed near an appliance.
 - placed near the wall.
 - placed near a light switch.
3. The electrical codes specifies the minimum AWG wire size allowable in a house for lighting circuits as:
- 18 AWG.
 - 14 AWG.
 - 12 AWG.
 - 16 AWG.
4. What is the minimum number of 15 ampere lighting circuits if the dwelling has an occupied area of 4,000 sq. ft.?
- 8
 - 6
 - 7
 - 9
5. Metal clad cable has a rating up to:
- 600 volts.
 - 700 volts.
 - 400 volts.
 - 500 volts.

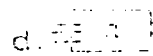
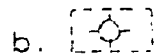
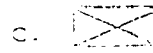
- 2.01.02.02.A2-2 6. The current carrying capacity of a conductor is called:
- ohms.
 - ampacity.
 - amps.
 - volts.
7. When stapling NM cable, the intervals must not exceed:
- 2'.
 - 3' 6".
 - 5'.
 - 4' 6".
8. Floor receptacles are not considered part of the required number of outlets unless they are:
- placed near a light switch.
 - placed near an appliance.
 - placed near a wall.
 - placed near a door.
9. Which of the following circumstances can metal clad cable be used in:
- underground
 - laying in masonry
 - through walls & partitions
 - exposed to weather
10. Which of the following abbreviations apply to metal clad cable or plastic insulated conductor?
- ACT
 - MCT
 - MT
 - MC
- 2.01.02.03.A2-2 11. Using the plan, which of the receptacles is the different height to center than the rest of the receptacles in the living room?
- those on the SW end of the room
 - one by the switch
 - the one by the TV
 - the one over the fireplace

- 01.02.03.A2-2 12. Approximately how far is it from the SW wall in the dining room to the switch on the NW wall of the dining room? (See Plans)
- 2' 11"
 - 2'
 - 4'
 - 3' 11"
13. When a GFR is installed in the main feeder of a power panel, it monitors what?
- the grounding circuit
 - all panel circuits
 - the single branch circuit
 - the convenience receptacles
14. On construction sites since 1/1/74, GFCI and ground fault interrupters required?
- in wet locations
 - indoors
 - outdoors
 - at all times
15. When does the code require special protection of cables in the attics of houses?
- when the stairs are provided
 - when access hole is provided
 - when no access hole is provided
 - when outside access hole is provided
- 01.02.03.A2-2 16. NMC cable must be strapped not more than _____ from the box of fitting?
- 12"
 - 18"
 - 14"
 - 16"
17. Notching the stud cable has sufficient strength _____
- metal covering
 - NMC cable
 - AWG cable
 - NM cable

- 72.01.02.04.A2-2 18. With the exception of bell wiring and fixture wiring, the insulation of most typical house wire is rated at:
- a. 200 volts
 - b. 400 volts
 - c. 800 volts
 - d. 600 volts
19. The electrical code requires at least what number of outlets for the laundry? (See Plans)
- a. two
 - b. four
 - c. three
 - d. one
20. When grounding a house, where can a grounding rod be grounded to?
- a. 10' pipe.
 - b. 2' pile aster.
 - c. 4' pole.
 - d. 2 2' rod.
- 72.01.02.05.A2-2 21. In a circuit with a breaker or 15 amps, 110-120 volts, what is the total wattage allowable for this circuit (approximate)?
- a. 1240 watts
 - b. 1440 watts
 - c. 1540 watts
 - d. 1040 watts
22. How many built-in appliances are included in the kitchen?
- a. six
 - b. two
 - c. eight
 - d. four
23. A three-wire 110/220 volt service is used for the kitchen. How many small appliances are permitted to be plugged into the service?
- a. four
 - b. one
 - c. three
 - d. two

01.02.05.A2-2

24. Which of the following is the symbol indicating a recessed ceiling fixture?



25. A three-wire 115/230 volt branch circuit is the equivalent of how many receptacle branch circuits 115V?

- a. four
- b. three
- c. one
- d. two

01.02.05.A2-2

26. According to the code, how many wires are required for the following (see plan)?

- a. grounding, two
- b. recessed
- c. standard
- d. grounding

27. If a grounding wire into a panel enters a box, it is counted as how many wires?

- a. four
- b. three
- c. two
- d. one

28. How many recessed fixtures are allowed in a room 12' x 12' x 8' high?

- a. four
- b. three
- c. two
- d. one

29. How many wires are required for a standard ceiling fixture?

- a. three
- b. one
- c. two
- d. zero

- 01.02.06.02-1 9. With the exception of two dryer and washer outlets, what is the height of the convenience receptacles (see plan)?
- 48" to center from FF
 - 18" to center from FF
 - 50" to center from FF
 - 17" to center from FF
- 01.02.07.02-1 9. In garages noted hazardous by the electrical code, convenience receptacles must be placed at the following heights above the floor minimum?
- 18"
 - 6"
 - 14"
 - 12"
- 01.02.07.02-1 9. According to the code, when is a receptacle required surrounding?
- all times
 - always
 - never
 - seldom
- 01.02.07.02-1 9. Which one of the following is not a use of a water pipe which is also a receptacle for a gas fitting, boiler, radiator?
- for air conditioning
 - for heating structure
 - for hot water
 - for steam heating
- 01.02.07.02-1 9. Which one of the following is not a use of a water pipe which is also a receptacle for a gas fitting, boiler, radiator?
- for air conditioning
 - for heating structure
 - for hot water
 - for steam heating
- 01.02.07.02-1 9. Which one of the following is not a use of a water pipe which is also a receptacle for a gas fitting, boiler, radiator?
- for air conditioning
 - for heating structure
 - for hot water
 - for steam heating
- 01.02.07.02-1 9. Which one of the following is not a use of a water pipe which is also a receptacle for a gas fitting, boiler, radiator?
- for air conditioning
 - for heating structure
 - for hot water
 - for steam heating

- 175

UNIT POST TEST ANSWER KEY: WIRING

LAP 01

1. c
2. c
3. c
4. c
5. a

LAP 05

21. b
22. a
23. d
24. b
25. d

LAP 02

6. b
7. d
8. c
9. c
10. a

LAP 06

26. d
27. d
28. d
29. b
30. d

LAP 03

11. d
12. a
13. b
14. d
15. a

LAP 07

31. a
32. b
33. b
34. a
35. b

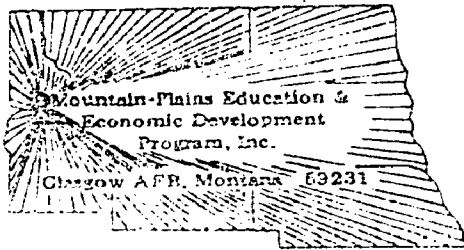
LAP 04

16. a
17. b
18. c
19. c
20. a

LAP 08

36. b
37. b
38. c
39. c
40. d

Family Pay Number: _____ Sex: M F (Circle 1)



UNIT PERFORMANCE TEST: WIRING

OBJECTIVE 1:

Given a blueprint, the student will make a sketch of an electric layout to determine control points and wire types and sizes, and conduit types and sizes.

OBJECTIVE 2:

Given a blueprint, the student will determine and obtain the necessary materials to complete the installation of various circuits.

OBJECTIVE 3:

The student will properly install ground fault interrupters; switching and lighting circuits; split receptacle circuits; and appliance circuits using various conduit types when necessary.

TASK:

The student will be given a floor plan of a particular room. The student will sketch the required electrical wiring installation; obtain tools, equipment, and supplies; and make the required electrical wiring installation as prescribed by the National Electrical Code and blueprint specifications.

ASSIGNMENT:CONDITIONS:

The student will be tested in a wood frame construction to simulate any specified room of a building. The student will be given a blueprint, tools and equipment. No assistance may be obtained from the instructor or from unspecified individuals.

RESOURCES:

Tools:

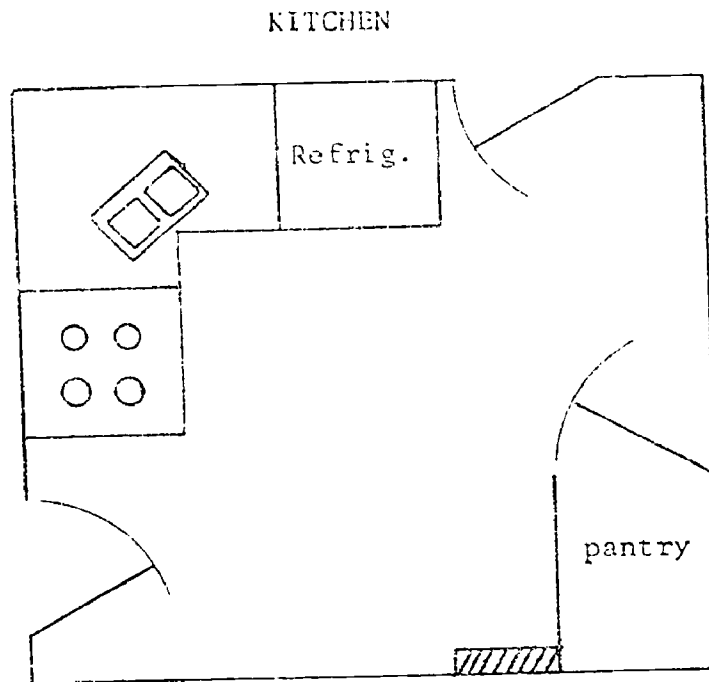
- High leverage plier
- High leverage oblique cutting plier
- Long nose cutting plier
- Electrician's hammer
- Screwdriver slot 3/16 x 4
- Screwdriver no. 2 phillips 8"
- Screwdriver slot 3/16 x 3
- Screwdriver 1/4 x 4
- Screwdriver 1/4 x 6
- Nutdriver variable size 1/4" x 7/16
- Scratch awl
- Adjustable wrench size 8"
- Pump plier size 10"
- All-purpose tool, wire stripper, crimper and cutter
- Tape rule 12' 3/4"
- Knife, electricians
- Tool pouch, 5 pocket

Equipment:

- Simson 260 VOM or Amprobe

Text:

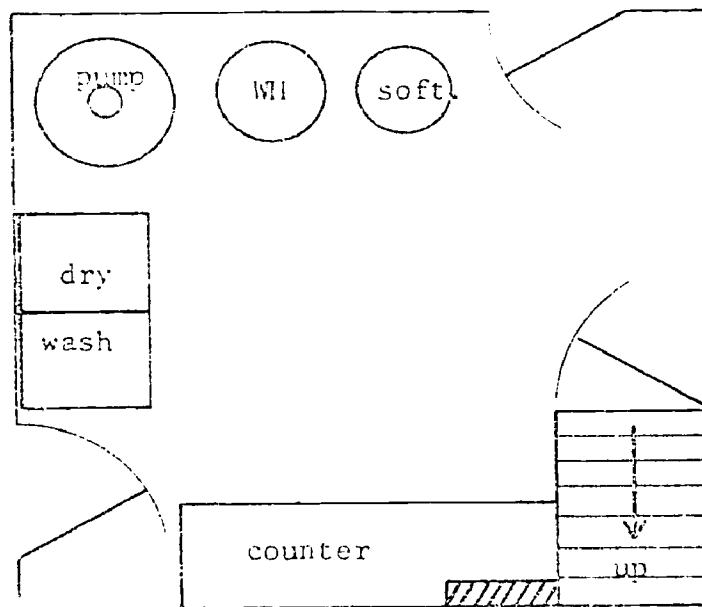
- Electrical Wiring Residential, Ray C. Mullin, Delmar Publishers, 4th Ed., 1973
- National Electrical Code

ASSIGNMENT SHEET 1

--garbage disposal
--pantry light
--light 2-position control

ASSIGNMENT SHEET 2

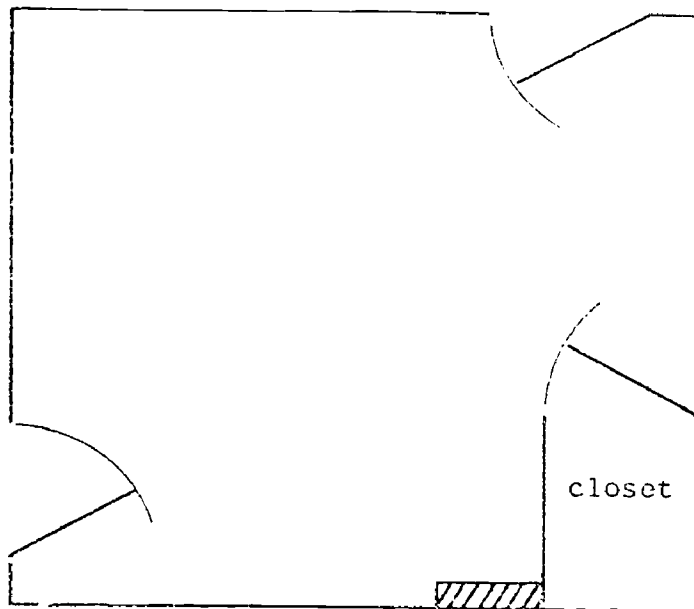
LAUNDRY ROOM



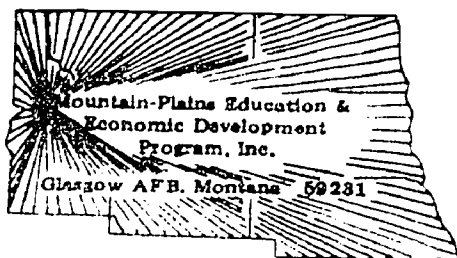
- sub-pump
- water heater
- water softener
- 3-position switch control

ASSIGNMENT SHEET 3

LIVING ROOM



--electric heat
--split receptacles
--2-position switch control



Family Pay Number: _____ Sex: M F (Circle 1)

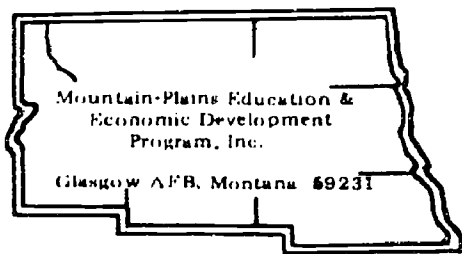
PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory _____ Unsatisfactory _____

	CRITERION	
	Met	Not Met
Objective 1:		
1. The student properly prepares a sketch of floor plan for electrical wiring.		
Criterion: The student uses the sketch while making the electrical wiring installation.		
Objective 2:		
2. The student properly selects wire size.		
3. The student properly selects wire types.		
4. The student properly selects conduit size.		
5. The student properly selects conduit types.		
Criterion: The wire and conduit dimensions meet National Electrical Code standards.		
Objective 3:		
6. The student properly installs switching circuits.		
7. The student properly installs lighting circuits.		

	CRITERION	
	Met	Not Met
8. The student properly installs split receptacle circuits.		
9. The student properly installs appliance circuits.		
10. The student fastens the electrical wire with appropriate staples.		
11. The student fastens the electrical wire at appropriate distance.		
12. The student properly installs Surface EMT.		
13. The student properly installs armored cable.		
14. The student fastens the electrical conduit with appropriate clips.		
15. The student fastens the electrical conduit at appropriate distances.		
Criterion: The installation meets National Electrical Code and blueprint specifications.		
16. The student will test each circuit for resistance.		
17. The student will test each circuit for current.		
18. The student will test each circuit for voltage.		
Criterion: The student uses safe, proper trouble-shooting techniques as outlined in AC/DC circuits student handbook.		
19. Task completed in allotted time.		

[illegible]



Learning Experience Guide

UNIT: SERVICE ENTRANCE

RATIONALE:

A wireman installs the electrical entrance service to the structure. To make this installation the wireman will do several things. He will layout the service entrance, and determine the type and size of the electrical entrance and the entrance panel. This is also required in the actual installation of the entrance service wiring and the service panel.

OBJECTIVE:

Identify electrical and mechanical requirements and procedures for installation of service entrances. Given blueprint specifications, National Electrical Codes, tools building or shop simulation, students will sketch layouts, estimate materials required and make installations of electrical service entrance for a specified structure.

RESOURCES:

Electrical Wiring Residential, Units 26 and 27, Delmar Publishers, 1973.

An assortment of electrical supply catalogs.

An assortment of manufacturer's electrical products specifications guides.

Set of electrical wireman's tools.

GENERAL INSTRUCTIONS:

As a student you will be assigned one or more performance activities in this unit. A LAP will be given you for each activity. In the LAP are directions and procedures to follow in completing the activity. At the end of the unit you will complete a test before continuing to the next unit in this course. If you have questions or problems discuss them with your instructor.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

PERFORMANCE ACTIVITIES:

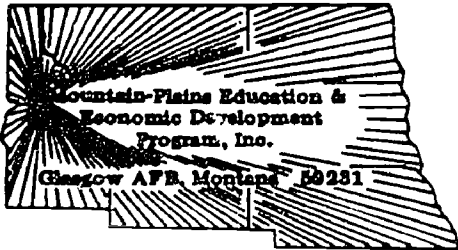
- .01 Laying Out Service Entrance on a Plan.
- .02 Determining the Type/Size of Service Entrance Panel.
- .03 ~~Determining the Size of Service Entrance.~~
- .05 Installing Service Entrance Panel.
- .06 Installing Service Entrance.

EVALUATION PROCEDURE:

Success in this unit is determined by identifying 80% of the desired response to a **set of multiple** choice test items and obtaining a "satisfactory" for **completing each line item** on a performance test.

FOLLOW-THROUGH:

Begin reading the first assigned LAP after you finish reading this unit guide. As you do the activity assigned, use the knowledge and skill you have acquired thus far.



UNIT PRETEST: SERVICE ENTRANCE

- 72.01.03.01.A2-2
1. With voltage between the conductors less than 300 volts and the feeder coming in through the roof, what is the maximum length up the roof (overhang) the cable can go over?
 - a. 2'
 - b. 5'
 - c. 4'
 - d. 3'
 2. Cartridge fuses shall not be used in systems that have a voltage in excess of which of the following (exception-neutral grounded: see NEC 240-6)?
 - a. 300 v
 - b. 120 v
 - c. 250 v
 - d. 150 v
 3. Type S fuses in cartridge form are labeled how?
 - a. SFC
 - b. SC
 - c. SDFC
 - d. DSC
 4. If the conductors of a service entrance are _____ or larger, insulating bushing must be installed (373-6(B)).
 - a. 8 AWC
 - b. 210 AWC
 - c. 0 AWC
 - d. 4 AWC
 5. To insure a low impedance path to ground, a service entrance must be which of the following?
 - a. banded
 - b. grounder
 - c. bonded
 - d. weather proof

- 72.01.03.02.A2-2 6. What is the maximum voltage permitted when using a bare neutral?
- a. 250 v
 - b. 300 v
 - c. 100 v
 - d. 150 v
7. For disconnect purposes of a building, what is the maximum number of breakers in one enclosure allowable?
- a. 6
 - b. 8
 - c. 2
 - d. 4
8. A panel board may not contain more than how many over current devices (NEC 384-15)?
- a. 36
 - b. 42
 - c. 32
 - d. 22
9. The voltage maximum allowable with a bare neutral is which of the following?
- a. ground to grounding
 - b. phase to ground
 - c. phase to phase
 - d. phase
10. If an underground service is to be made, which of the following would be acceptable?
- a. NM
 - b. RHW
 - c. NNC
 - d. USE
- 72.01.03.03.A2-2 11. Which of the following require mechanical protection under normal conditions?
- a. No. 2 grounding conductor
 - b. No. 6 grounding conductor
 - c. No. 4 grounding conductor
 - d. No. 8 grounding conductor

- 72.01.03.03.A2-2** 12. The NEC states that the service entrance includes all drops from a pole to and including which of the following?
- a. conduit
 - b. splices
 - c. power panel
 - d. meter base
13. When No. 4 awg conductors are installed in conduit, what is required on the conduit ends?
- a. coupling
 - b. bands
 - c. insuliners
 - d. bushings
14. Which of the following sections in the NEC covers the point of attachment of a service entrance (See NEC)?
- a. 250-94
 - b. 230-25
 - c. 373-6
 - d. 230-94
15. What part of a circuit breaker causes the breaker to trip on a short circuit?
- a. capacitor
 - b. magnetic coil
 - c. thermostat
 - d. bimetal strip
- 72.01.03.04.A2-2** 16. What is the minimum service drop clearance over alleys?
- a. 14'
 - b. 16'
 - c. 18'
 - d. 12'
17. A method of service disconnect may consist of how many switches or circuit breakers?
- a. 2
 - b. 6
 - c. 3
 - d. 4

72.01.03.04.A2-2 18. Where does a service entrance start?

- a. attachment at service drop conductor
- b. attachment at the weather head
- c. attachment at the pole
- d. attachment at transformer

19. Where does a service entrance end?

- a. at the conduit connection
- b. at the terminal drop
- c. at the terminals weather head
- d. at the terminals of SE equipment

20. Which of the following fittings is usually used in a service entrance when a 90 degree turn must be made?

- a. L
- b. LB
- c. weather head
- d. coupling

72.01.03.05.A2-2 21. What load rating may be used for a range rated not over 12 KW (220-5)?

- a. 12 KW
- b. 10 KW
- c. 8 KW
- d. 6 KW

22. If a house has 10 appliance circuits, what is the total load for appliance circuits in watts?

- a. 15,000 watts
- b. 25,000 watts
- c. 10,000 watts
- d. 20,000 watts

23. If a wall mounted oven and a cooking unit total 14,050 watts, what are the total watts used to determine this single circuit load (220-5)?

- a. 5500 watts
- b. 7500 watts
- c. 8800 watts
- d. 14,050 watts

- 2.01.02.05.A2-2 24. The electric range for a house may be considered to be which of the following ratings (table 220-5)?
- a. 10 KW
 - b. 6 KW
 - c. 4 KW
 - d. 8 KW
25. In general, copper service entrance conductors shall not be smaller than which of the following?
- a. 8 AWG
 - b. 6 AWG
 - c. 4 AWG
 - d. 2 AWG

UNIT PRETEST ANSWER KEY: SERVICE ENTRANCE**LAP 01**

1. c
2. a
3. b
4. d
5. c

LAP 04

16. c
17. b
18. a
19. d
20. b

LAP 02

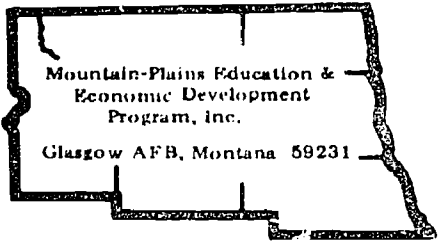
6. b
7. a
8. b
9. b
10. d

LAP 05

21. c
22. a
23. c
24. d
25. b

LAP 03

11. d
12. b
13. c
14. b
15. b



Mountain-Plains Education &
Economic Development
Program, Inc.

Glasgow AFB, Montana 59231

Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Laying Out Service Entrance on a Plan

OBJECTIVE:

Given the necessary tools, equipment, materials, supplies, and a floor plan, sketch in and label the service entrance. Sketch must be complete with information and standards identified in the resource text. Identify the information related to the electrical requirements for service entrance. Recognize the procedures for laying out a service entrance.

EVALUATION PROCEDURE:

Accurate completion of the sketch to the standards described in the test. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

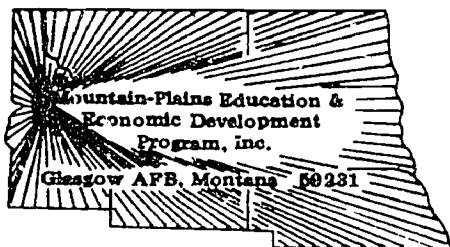
RESOURCES:

Electrical Wiring, Ray C. Mullin, pp. 232-261.

PROCEDURE:

1. Read the text reference, pp. 232-261 Units 26 and 27.
2. Answer the questions on pp. 251-255, 260 and 261.
3. Using the floor plan (obtain from the instructor) and the resources listed as reference, sketch on the blueprint, the service entrance necessary to comply with the resource specifications.
NOTE: Make your sketches on the plan neat and clear. Follow the procedure presented in the text.
4. When you have completed 1-4 compile the requested data on your Performance Record.
5. Go to your instructor for evaluation and checkoff. Have the instructor initial your Performance Record in the appropriate space.
6. Take the test for this LAP.
7. Score the LAP test and return it.
8. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

Principal Author(s): R. Arneson, L. Leland, T. Ziller



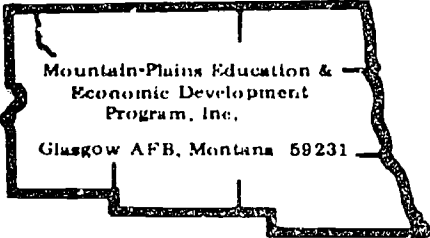
LAP TEST: LAYING OUT SERVICE ENTRANCE ON PLAN

1. On which outside wall of the house is the meter (electric) mounted (see plan)?
 - a. NE
 - b. SW
 - c. SE
 - d. NW
2. Type S fuses in cartridge form are labeled how?
 - a. SFC
 - b. SC
 - c. SDFC
 - d. DSC
3. If a service entrance has three No. 20 conductors, what size grounding conductor is required by the NEC (250-94(A))?
 - a. 0 AWG
 - b. 3 AWG
 - c. 2 AWG
 - d. 4 AWG
4. With voltage between the conductors less than 300 volts and the feeder coming in through the roof, what is the maximum length up the roof (overhang) the cable can go over?
 - a. 3'
 - b. 2'
 - c. 5'
 - d. 4'
5. With voltage between the conductors less than 300 volts, what is the minimum height allowable if the feeder is coming into the side of a house?
 - a. 2' 6"
 - b. 2'
 - c. 1'
 - d. 1' 6"

6. Which of the following fuses has a rating of 200,000 amperes R.M.S. symmetrical?
- cartridge
 - SFC
 - SC
 - SDFC
7. With voltage between conductors less than 300 volts, what is the minimum clearance off a roof if the feeder is running parallel with the roof?
- 3'
 - 4'
 - 2'
 - 1'
8. Which of the following type fuses are required on all new installations?
- type G
 - type X
 - type S
 - type F
9. Plug fuses shall not be used in circuits exceeding what number of volts between conductors. The exception is a grounded neutral (see NEC 240-6).
- 125 v
 - 120 v
 - 110 v
 - 115 v
10. If the conductors of a service entrance are _____ of larger, insulating bushes must be installed (373-5(B)).
- 210 AWC
 - 0 AWC
 - 4 AWC
 - 8 AWC

LAP TEST ANSWER KEY: LAYING OUT SERVICE ENTRANCE ON PLAN

1. c
2. b
3. d
4. d
5. d
6. a
7. a
8. c
9. a
10. c



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Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Determining Type/Size of Service Entrance Panel

OBJECTIVE:

Given a blueprint specifications, identify and record on a requisition form, the type and description, of the service entrance panel. Compiled data must correlate to and conform with the listed references. Recognize the procedures for determining the type and size of service entrance panel. Identify the information related to service entrance panel size and type determination.

EVALUATION PROCEDURE:

Accurate ordering of the parts and supplies needed to complete the specific job listed in the objective and on the blueprint. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Supply Catalog.
Electrical Wiring, Ray C. Mullin, pp. 232-261.

PROCEDURE:

1. Obtain an Electrical Parts Supply Catalog.
2. Using the attached requisition and the blueprint sketch you have completed, order the parts and supplies needed to complete the job indicated in the objective.
NOTE: Parts and supplies must be ordered by quantity, complete description and type.
3. Check your completed requisition with the answer key.
4. Enter the requested data on your Performance Record.
5. Take the test for this LAP.
6. Score the LAP test and return it.
7. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

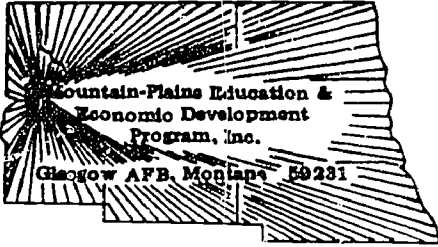
Post Office Box 3078
Glasgow AFB, Montana 58231

PURCHASE REQUISITION

72.01.03.02.A2-0

- ORIGINATOR'S CONTROL NO. -

REQUISITION NO.		REQUISITION DATE		TIME REQUIRED		PURCHASE ORDER NO.		PAGE of			
<input type="checkbox"/> RESEARCH DEVELOPMENT <input type="checkbox"/> START UP				<input type="checkbox"/> OPERATIONS		ACCOUNTING DATA		DEPARTMENT <input type="checkbox"/> ADMINISTRATION <input type="checkbox"/> FAMILY LIFE <input type="checkbox"/> INSTRUCTION <input type="checkbox"/> MULTI-PURPOSE <input type="checkbox"/> STATE PROGRAMS <input type="checkbox"/> PLANNING & RESEARCH <input type="checkbox"/> OTHER			
SUGGESTED SOURCE						USING ACTIVITY					
						USED FOR					
ITEM NO.	QUAN.	UNIT	DESCRIPTION OF SUPPLIES / SERVICES					EST. UNIT PRICE	EST. AMOUNT		
REMARKS								EST. TOTAL AMOUNT			
Title		Signature		Date		Title		Signature		Date	
ORIGINATOR						PROPERTY CONTROLLER					
DEPT. HEAD						PROCUREMENT OFFICER					
DIRECTOR						ACCOUNTING OFFICE (To Procurement)					



LAP TEST: ~~DETERMINING~~ DETERMINING TYPE/SIZE OF SERVICE
ENTRANCE PANEL

1. What size conduit will be installed for the service entrance? (See Plans)
 - a. 2 1/2"
 - b. 2"
 - c. 1 1/2"
 - d. 1 1/4"
2. If an underground service is to be made, which of the following would be acceptable?
 - a. RHW
 - b. NNC
 - c. USE
 - d. NM
3. What is the recommended maximum height of a meter base?
 - a. 4'
 - b. 3'
 - c. 6'
 - d. 5'
4. For disconnect purposes of a building, what is the maximum number of breakers in one enclosure allowable?
 - a. 2
 - b. 4
 - c. 6
 - d. 8
5. A panel board may not contain more than how many over current devices? (NEC 384-15)
 - a. 36
 - b. 32
 - c. 22
 - d. 42

6. What type of cable is to be used in this service entrance (see specs)?
 - a. FEP
 - b. RHW
 - c. SEC
 - d. FEPP

7. If the voltage to ground is less than 300 volts, the grounded conductor need not be:
 - a. NMC.
 - b. copper.
 - c. insulated.
 - d. aluminum.

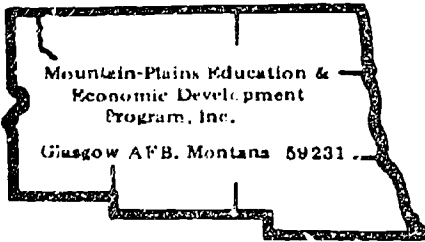
8. What **type** of service entrance box is to be installed in this house (see specs)?
 - a. **recessed/flush**
 - b. combination flush / surface
 - c. **surface mount**
 - d. either

9. What **is the** minimum size service entrance cable allowable by the NEC (copper)?
 - a. **8 AWG**
 - b. **6 AWG**
 - c. **210 AWG**
 - d. **0 AWG**

10. If a **service entrance** cable passed over the peak of a house, what is the minimum clearance allowable?
 - a. 8'
 - b. 4'
 - c. 6'
 - d. 10'

LAP TEST ANSWER KEY: **DETERMINING TYPE/SIZE OF SERVICE
ENTRANCE PANEL**

1. b
2. c
3. c
4. c
5. d
6. b
7. c
8. c
9. a
10. a



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Determining Size of Service Entrance

OBJECTIVE:

Given a blueprint and specifications, identify and record on a requisition form, the type and description of the service entrance materials. Compiled data must correlate to and conform with the listed references and standards established in the industry. Identify the related electrical requirements for determining the size of service entrance.

EVALUATION PROCEDURE:

Accurate ordering of the parts and supplies needed to complete the specific job listed in the objective and on the blueprint. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Supply Catalog.
Electrical Wiring, Ray C. Mullin, pp. 232-261.

PROCEDURE:

1. Obtain an Electrical Parts Supply Catalog.
2. Using the attached requisition and the blueprint sketch you have completed, order the parts and supplies needed to complete the job indicated in the objective.
NOTE: Parts and supplies must be ordered by quantity, complete description and type.
3. Check your completed requisition with the answer key.
4. Enter the requested data on your Performance Record.
5. Take the test for this LAP.
6. Score the LAP test and return it.
7. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

Post Office Box 3078
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— ORIGINATOR'S CONTROL NO. —

REQUISITION NO. _____ REQUISITION DATE _____ TIME REQUIRED _____ PURCHASE ORDER NO. _____

[] RESEARCH DEVELOPMENT [] OPERATIONS
[] START UP

ACCOUNTING DATA

DEPARTMENT

SUGGESTED SOURCE

USING ACTIVITY

[] ADMINISTRATION

[] FAMILY LIFE

[] INSTRUCTION

☐ MULTI-PURPOSE

[] STATE PROGRAMS

☐ PLANNING & RESEARCH

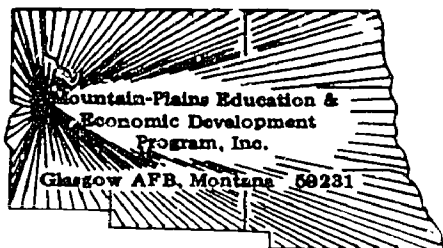
☐ OTHER

ITEM NO.	QUAN.	UNIT	DESCRIPTION OF SUPPLIES / SERVICES	EST. UNIT PRICE	EST. AMOUNT

REMARKS

EST. TOTAL
AMOUNT

Title	Signature	Date	Title	Signature	Date
ORIGINATOR			PROPERTY CONTROLLER		
DEPT. HEAD			PROCUREMENT OFFICER		
DIRECTOR			ACCOUNTING OFFICE (To Procurement)		



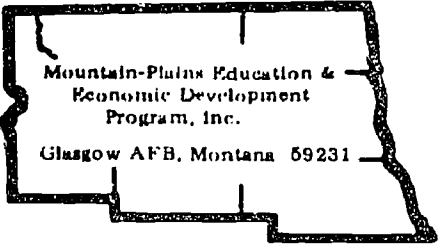
LAP TEST: DETERMINING SIZE OF SERVICE ENTRANCE

1. Which of the following are required on service entrances?
 - a. bonding couplings
 - b. bonding bushings
 - c. couplings
 - d. bushings
2. What is the maximum voltage between conductors allowable when plug fuses are used?
 - a. 125 v
 - b. 150 v
 - c. 200 v
 - d. 100 v
3. How many meters are provided for this residence (see plan)?
 - a. three
 - b. two
 - c. one
 - d. four
4. On what type of wall is panel B fastened in this house (see plan)?
 - a. concrete
 - b. sheet rock
 - c. paneling
 - d. cinder block
5. On what type of wall is panel A fastened in this residence (see plan)?
 - a. sheet rock
 - b. paneling
 - c. cinder block
 - d. concrete

6. Which of the following require mechanical protection under normal conditions?
 - a. No. 6 grounding conductor
 - b. No. 8 grounding conductor
 - c. No. 2 grounding conductor
 - d. No. 4 grounding conductor
7. What size ungrounded conductors are installed for a 100 amp service (see NEC 310-12)?
 - a. 4 RHW
 - b. 2 RHW
 - c. 6 RHW
 - d. 0 RHW
8. What part of a circuit breaker causes the breaker to trip on a short circuit?
 - a. magnetic coil
 - b. thermostat
 - c. capacitor
 - d. bimetal strip
9. Which of the following sections in the NEC covers the point of attachment of a service entrance (see NEC)?
 - a. 230-94
 - b. 250-94
 - c. 373-6
 - d. 230-26
10. What is the minimum height from finish grade that a meter base can be positioned?
 - a. 5'
 - b. 3'
 - c. 4'
 - d. 6'

LAP TEST ANSWER KEY: DETERMINING SIZE OF SERVICE ENTRANCE

1. b
2. a
3. c
4. a
5. c
6. b
7. a
8. a
9. d
10. c



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Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Installing Service Entrance Panel

OBJECTIVE:

Given the necessary tools, equipment, supplies and blueprint, correctly install a service entrance panel according to manufacturer's and blueprint specifications; following procedures and practices accepted in the industry and outlined in the reference text. Identify the electrical requirements and procedures for installation of service entrance panels.

EVALUATION PROCEDURE:

Installation meets the criteria listed on the attached checklist. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray Mullin, pp. 232-255.
Manufacturer's Specifications.

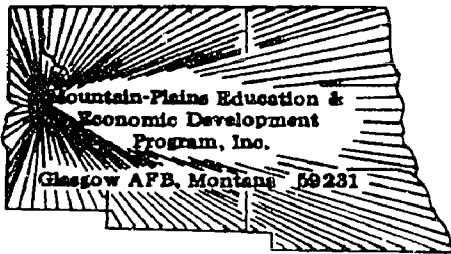
PROCEDURE:

1. Go to your assigned work station where you will complete the activities listed in the objective. Review the text if necessary.
2. Obtain the necessary tools, equipment and supplies needed to complete the operations listed.
3. Complete the job listed in the objective.
NOTE: FOLLOW SAFE PRACTICES AND PROCEDURES.
4. Perform all necessary testing and evaluation checks listed in the checklist. If you have any questions or problems, check with the instructor.
5. When you have been checked off on the checklist by the instructor, complete the data requested on your Performance Record and have him initial it.
6. Clean up the area.
7. Take the test for this LAP.
8. Score the LAP test and return it.
9. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

CHECKLIST: INSTALLING SERVICE ENTRANCE PANELS

- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.



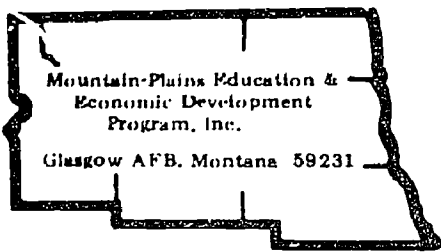
LAP TEST: INSTALLING SERVICE ENTRANCE PANEL

1. Which of the following is probably the most common type of service entrance?
 - a. mast
 - b. interior
 - c. post
 - d. underground
2. What is the minimum service drop clearance over alleys?
 - a. 16'
 - b. 14'
 - c. 12'
 - d. 18'
3. What is the minimum service drop clearance over private sidewalks?
 - a. 14'
 - b. 8'
 - c. 10'
 - d. 12'
4. Disconnect devices must be in how many enclosures?
 - a. one
 - b. four
 - c. three
 - d. two
5. What section of the code specifies the location of the service head (see NEC)?
 - a. 320-72
 - b. 430-5
 - c. 250-6
 - d. 230-1

6. Which of the following is used to connect grounding conductor to a water pipe?
 - a. clamp
 - b. EMT
 - c. coupler
 - d. coupling
7. Where is grounding of the electrical system in this house done (see plan)?
 - a. rec room
 - b. utility room
 - c. work shop
 - d. pump room
8. Who usually determines service location?
 - a. power company
 - b. electrical inspector
 - c. city authorities
 - d. owner
9. Where does a service entrance start?
 - a. attachment at the service drop conductor
 - b. attachment at the transformer
 - c. attachment at the pole
 - d. attachment at the weatherhead
10. Which section of the code covers the burying of bar conductors?
 - a. 230-30
 - b. 370-9 (B)
 - c. 225-2 (A)
 - d. 219-6

LAP TEST ANSWER KEY: INSTALLING SERVICE ENTRANCE PANEL

1. a
2. d
3. c
4. a
5. d
6. a
7. d
8. a
9. a
10. a



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Installing Service Entrance**OBJECTIVE:**

Given the necessary tools, equipment, supplies and blueprint, correctly install a service entrance according to manufacturer's and blueprint specifications; following procedures and practices accepted in the industry and outlined in the reference text. Identify the electrical requirements and procedures for installing the service entrance.

EVALUATION PROCEDURE:

Installation meets the criteria listed on the attached checklist. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray Mullin, pp. 256-261.
Manufacturer's Specifications.

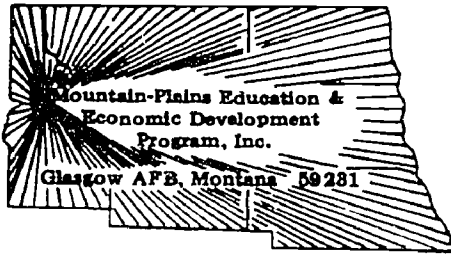
PROCEDURE:

1. Go to your assigned work station where you will complete the activities listed in the objective. Review the text if necessary.
2. Obtain the necessary tools, equipment and supplies needed to complete the operations listed.
3. Complete the job listed in the objective.
NOTE: FOLLOW SAFE PRACTICES AND PROCEDURES.
4. Perform all necessary testing and evaluation checks listed in the checklist. If you have any questions or problems, check with the instructor.
5. Clean up the area.
6. Take the test for this LAP.
7. Score the LAP test and return it.
8. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

CHECKLIST: INSTALLING SERVICE ENTRANCES

- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.

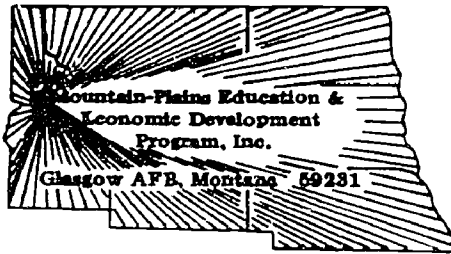
LAP TEST: **INSTALLING SERVICE ENTRANCE**

1. In general, service entrance conductors shall not be smaller than which of the following?
 - a. **4 AWC**
 - b. **8 AWC**
 - c. **6 AWC**
 - d. **2 AWC**
2. What load rating may be used for a range rated not over 12 KW (220-5)?
 - a. 6 KW
 - b. 8 KW
 - c. 10 KW
 - d. 12 KW
3. If a house has 1000 square foot of space, what is the general lighting load in watts?
 - a. 4000 watts
 - b. 2000 watts
 - c. 3000 watts
 - d. 1000 watts
4. Any house that uses electric cooking facilities must have a service entrance larger than which of the following?
 - a. 100 amp
 - b. 60 amp
 - c. 80 amp
 - d. 125 amp
5. If a wall mounted oven and a cooking unit total 14,050 watts, what are the total watts used to determine this single circuit load (220-5)?
 - a. **14,150 watts**
 - b. ~~8000 watts~~
 - c. **5500 watts**
 - d. 7500 watts

6. If electric heat load is 15,500 watts and air conditioning load is 5760, what is the total load in watts for this single circuit (220-4(l))?
- a. 21,260 watts
 - b. 15,500 watts
 - c. 24,300 watts
 - d. 5760 watts
7. What electric range for a house may be considered to be which of the following ratings (table 220-5)?
- a. 10 KW
 - b. 6 KW
 - c. 8 KW
 - d. 4 KW
8. What is the demand factor for the general lighting load of houses from 0 to 300 watts?
- a. 100%
 - b. 90%
 - c. 80%
 - d. 75%
9. If a house has 10 appliance circuits, what is the total load for appliance circuits in watts?
- a. 25,000 watts
 - b. 20,000 watts
 - c. 15,000 watts
 - d. 10,000 watts
10. What is the minimum number of small appliance circuits permitted by the code?
- a. one
 - b. four
 - c. three
 - d. two

LAP TEST ANSWER KEY: INSTALLING SERVICE ENTRANCE

1. c
2. b
3. c
4. a
5. a
6. b
7. c
8. a
9. c
10. d



UNIT POST TEST: SERVICE ENTRANCE

- 2.01.03.01.A2-2
1. Which of the following fuses has a rating of 200,000 amperes R.M.S. symmetrical?
 - a. SFC
 - b. SDFC
 - c. SC
 - d. cartridge
 2. With voltage between conductors less than 300 volts, what is the minimum clearance off a roof if the feeder is running parallel with the roof?
 - a. 1'
 - b. 2'
 - c. 4'
 - d. 3'
 3. Which of the following fuses has a rating of 100,000 amperes R.M.S. symmetrical?
 - a. cartridge
 - b. SDFC
 - c. SC
 - d. SFC
 4. On which outside wall of the house is the meter (electric) mounted (see plan)?
 - a. SW
 - b. SE
 - c. NW
 - d. NE
 5. Which of the following type fuses are required on all new installations?
 - a. type F
 - b. type G
 - c. type S
 - d. type X

- 72.01.03.02.A2-2 6. What type of service entrance box is to be installed in this house (see specs)?
- a. surface mount
 - b. combination flush / surface
 - c. either
 - d. recessed / flush
7. What is the minimum service drop clearance from a fence that can be walked upon?
- a. 10'
 - b. 12'
 - c. 14'
 - d. 8'
8. What size conductors are installed for this residence service (see specs)?
- a. 3/0
 - b. 4/0
 - c. 2/0
 - d. 0
9. What is the recommended maximum height of a meter base?
- a. 4'
 - b. 5'
 - c. 3'
 - d. 6'
10. What size conduit will be installed for the service entrance? (See Plans)
- a. 1 1/4"
 - b. 2 1/2"
 - c. 1 1/2"
 - d. 2"
- 2.01.03.03.A2-2 11. On what type of wall is panel A fastened in this residence (see plan)?
- a. sheetrock
 - b. concrete
 - c. cinder block
 - d. paneling

- 72.01.03.03.A2-2 12. If the power company allows it (lower cost for electrical heat) , how many meters do homes need?
- a. one
 - b. two
 - c. four
 - d. three
13. Which of the following are required on service entrances?
- a. bushings
 - b. couplings
 - c. bonding bushings
 - d. bonding couplings
14. What is the minimum height from finish grade that a meter base can be positioned?
- a. 5'
 - b. 6'
 - c. 3'
 - d. 4'
15. On what type of wall is panel B fastened in this house (see plan)?
- a. sheet rock
 - b. cinder block
 - c. paneling
 - d. concrete
- 72.01.03.04.A2-2 16. Which of the following is probably the most common type of service entrance?
- a. post
 - b. interior
 - c. underground
 - d. mast
17. What is the minimum service drop clearance over a private driveway?
- a. 8'
 - b. 12'
 - c. 14'
 - d. 10'

- 72.01.03.04.A2-2 18. What section of the code specifies the location of the service head (see NEC)?
- 320-72
 - 250-6
 - 430-5
 - 230-51
19. What is the ampere rating required for the main copper buses (or bus bars) in panel B (see specs)?
- 150 amp
 - 200 amp
 - 100 amp
 - 125 amp
20. How high up must mechanical protection be provided where underground service conductors are carried up a pole?
- 8'
 - 4'
 - 6'
 - 10'
- 72.01.02.05.A2-2 21. What is the demand factor for the general lighting load of a house from 3000 to 120,000 watts?
- 50%
 - 25%
 - 60%
 - 40%
22. What is the minimum number of small appliance circuits permitted by the code?
- one
 - four
 - two
 - three
23. What is the demand factor for the general lighting of houses from 0 to 3000 watts?
- 100%
 - 90%
 - 75%
 - 80%

- 72.01.03.05.A2-2** 24. If a house has 1000 square foot of space, what is the general lighting load in watts?
- a. 4000 watts
 - b. 2000 watts
 - c. 3000 watts
 - d. 1000 watts
25. Any house that uses electric cooking facilities must have a service entrance larger than which of the following?
- a. 125 amp
 - b. 60 amp
 - c. 80 amp
 - d. 100 amp

UNIT POST TEST ANSWER KEY: SERVICE ENTRANCE

LAP 01

1. d
2. d
3. c
4. b
5. c

LAP 05

16. d
17. b
18. d
19. d
20. a

LAP 02

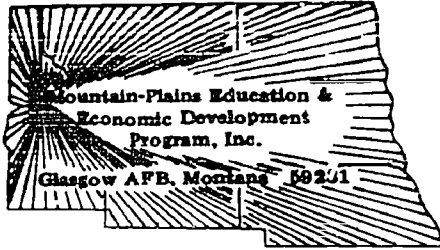
6. d
7. a
8. c
9. d
10. d

LAP 06

21. d
22. c
23. a
24. c
25. d

LAP 03

11. c
12. b
13. c
14. d
15. d



Family Pay Number: _____ Sex: M F (Circle 1)

UNIT PERFORMANCE TEST: SERVICE ENTRANCE

OBJECTIVE 1:

Given a blueprint, the student will make a sketch of an electrical service entrance to determine location.

OBJECTIVE 2:

Given a blueprint, the student will determine and obtain materials necessary to complete an electrical service entrance.

OBJECTIVE 3:

The student will properly install an electrical service entrance.

TASK:

The student will be given a particular floor plan of a room. The student will then sketch the required electrical service entrance installation; obtain tools, equipment, and supplies, and install the required electrical service entrance as prescribed by the National Electrical Code and blueprint specifications.

ASSIGNMENT:CONDITIONS:

The student will be tested in a wood frame construction to simulate any specified room of a residence. The student will be given necessary tools and equipment. No assistance may be obtained from another student or the instructor or from unspecified text material.

RESOURCES:

Tools:

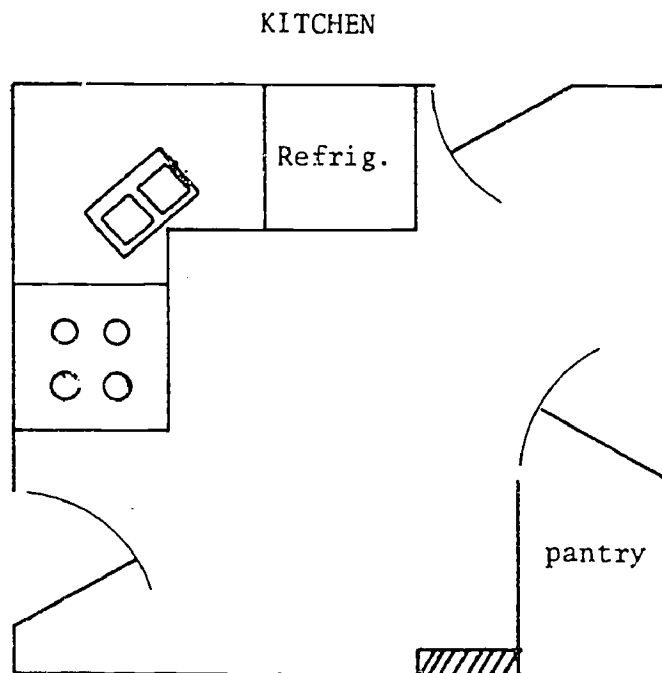
High leverage plier
High leverage oblique cutting plier
Long nose cutting plier
Electrician's hammer
Screwdriver slot 3/16 x 4
Screwdriver no. 2 phillips 8"
Screwdriver slot 3/16 x 9
Screwdriver 1/4 x 4
Screwdriver 1/4 x 6
Nutdriver variable size 1/4" x 7/16
Scratch awl
Adjustable wrench size 8"
Pump plier size 10"
All-purpose tool, wire stripper, crimper and cutter
Tape rule 12' 3/4"
Knife, Electricians
Tool Pouch, 5 pocket

Equipment:

Simpson 260 VOM or Amprobe

Text:

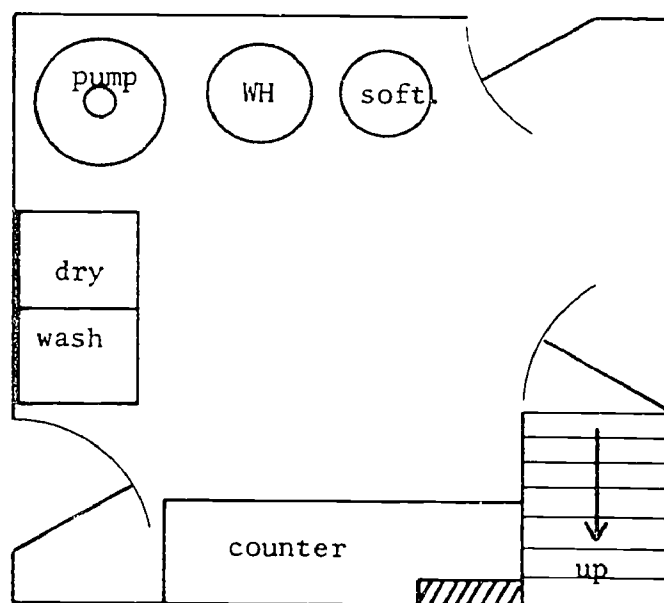
Electrical Wiring Residential, Ray C. Mullin, Delmar Publishers, 4th Ed., 1973
National Electrical Code

ASSIGNMENT SHEET 1

- garbage disposal
- pantry light
- light 2-position control

ASSIGNMENT SHEET 2

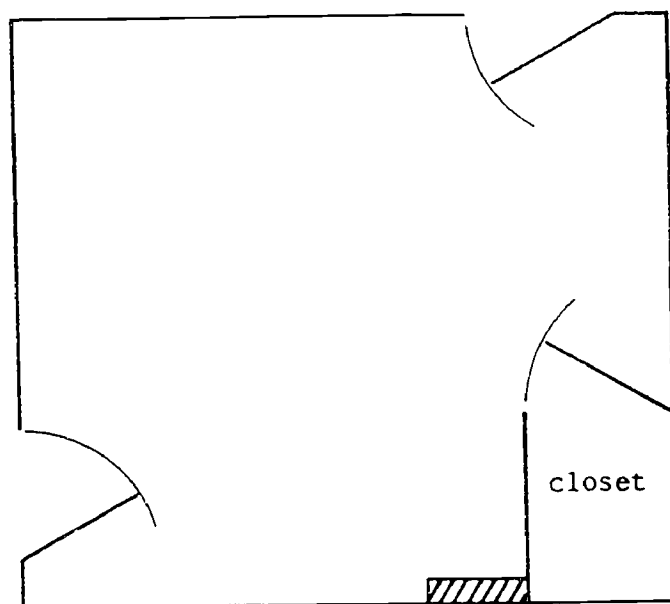
LAUNDRY ROOM



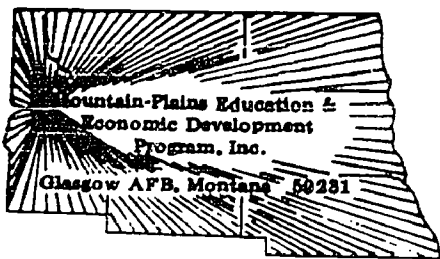
- sub-pump
- water heater
- water softener
- 3-position switch control

ASSIGNMENT SHEET 3

LIVING ROOM



- electric heat
- split receptacles
- 2-position switch control



Student: _____ File Code: _____
 Date: _____ Date Published: 11/7/74

Family Pay Number: _____ Sex: M F (Circle 1)

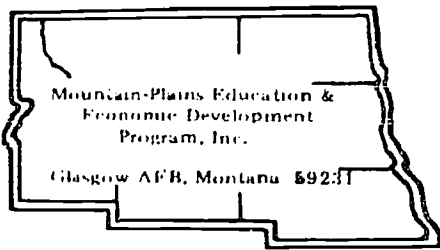
PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory _____ Unsatisfactory _____

	CRITERION	
	Met	Not Met
Objective 1:		
1. The student properly prepares a sketch to determine location of an electrical service entrance.		
Criterion: The student uses the sketch while making the electrical service entrance installation.		
Objective 2:		
2. The student determines the proper electrical entrance size.		
3. The student determines the proper electrical service entrance type.		
4. The student determines proper service entrance conduit size.		
5. The student determines the proper service entrance conduit type.		
Criterion: The dimensions meet National Electrical standards and floor plan		

(Checklist continued)

	CRITERION	
	Met	Not Met
specifications.		
Objective 3:		
6. The student will install service entrance at the proper height.		
7. The student will install service entrance plum with exiting wall.		
8. The student will bond properly the service entrance.		
9. The student will ground service entrance properly.		
Criterion: The installation meets National Electrical Code and floor plan specifications.		
10. Task completed in allotted time.		
Criterion: See assignment for time specifications.		
Student must meet criterion on all line items to obtain an overall score of satisfactory.		



Learning Experience Guide

UNIT: SIGNAL AND LOW VOLTAGE

RATIONALE:

The skill acquired in this unit will prepare you for part of the wireman's duties. These duties involve installing circuits for signal and other low voltage systems. It is common for a variety of these circuits to be part of most electrical plans in today's structures.

OBJECTIVE:

Identify electrical requirements and procedures for installing low voltage circuits. Given blueprint specifications, National Electrical Codes, tools, building or shop simulation, student will sketch layout, estimate materials required and make installations of low voltage electrical circuits.

RESOURCES:

Electrical Wiring Residential, Delmar Publishers, 1973.

An assortment of electrical supply catalogs.

An assortment of manufacturer's electrical products specifications guides.

Set of electrical wireman's tools.

Film Loops:

Series Circuit, Fairfield Associates, the Jam Handy Organization.

Parallel Circuit, Fairfield Associates, the Jam Handy Organization.

Dimmer Controls, Fairfield Associates, the Jam Handy Organization.

Audio Cassette Tapes.

Narrations for each of the film loops listed, Mountain-Plains Education & Economic Development Programs, Inc.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

GENERAL INSTRUCTIONS:

You will be assigned performance activities about layout, materials determination, and installations. A LAP will be given to you for each assigned activity. The LAP provides the direction and procedures for the activity. Complete the activities as assigned and take the unit test. Problems or questions that arise should be discussed with the instructor.

PERFORMANCE ACTIVITIES:

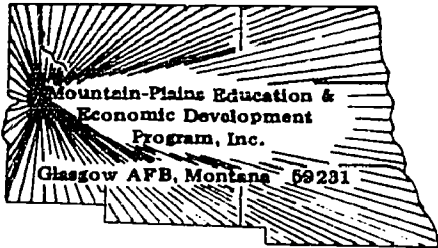
- .01 Laying Out Signal Circuits on a Plan
- .02 Determining Type of Signal System
- .03 Installing Dimmer Controls
- .04 Installing Signal Systems
- .05 Laying Out Low-Voltage Circuits on a Plan
- .06 Installing Low-Voltage Wiring Systems

EVALUATION PROCEDURE:

Success in this unit is determined by identifying 80% of the desired responses to a set of **multiple** choice test items and obtaining a "satisfactory" for completing each line item on a performance test.

FOLLOW-THROUGH:

This is the last unit in this course. After reading this unit guide, begin reading the first assigned LAP. Use the skills acquired in previous units to complete the assigned activities. When you master the unit test, the next course will be assigned.



UNIT PRETEST: SIGNAL AND LOW VOLTAGE SYSTEMS

- 72.01.04.01.A2-2
1. Most telephone companies require a minimum of how many phones to be installed in a house permanently?
 - a. one
 - b. two
 - c. three
 - d. four
 2. A phone jack has how many prongs on it?
 - a. one
 - b. four
 - c. three
 - d. two
 3. How many solenoids are contained in a two-tone chime?
 - a. four
 - b. three
 - c. one
 - d. two
 4. In which of the following must EMT be used for telephone service?
 - a. residence, no basement masonry
 - b. residence
 - c. residence, no basement
 - d. residence with basement masonry
 5. What size wire is usually installed for signal system of the type in this residence?
 - a. 14 AWG
 - b. 12 AWG
 - c. 16 AWG
 - d. 18 AWG

- 72.01.04.02.A2-2 6. If a TV outlet is to have both the low voltage outlet and 120 voltage in one box, what must be provided?
- a. it is not allowable
 - b. a switch
 - c. barrier between the two
 - d. a rheostat
7. Using unshielded lead in cable may result in which of the following?
- a. poor color reception
 - b. poor audio reception
 - c. damage to the set
 - d. poor sound reception
8. Unshielded TV input cable should not be installed near which of the following?
- a. plastic
 - b. glass
 - c. pipes
 - d. wood members
9. What type boxes are recommended when non shielded lead-in wire is used for a television circuit?
- a. metal
 - b. nonmetallic
 - c. DWV
 - d. special television
10. What is the OHM rating of the coaxial cable used to service each TV?
- a. 300 OHM
 - b. 100 OHM
 - c. 500 OHM
 - d. 75 OHM
- 72.01.04.03.A2-2 11. What function does the dimmer on a fluorescent light perform?
- a. stabilizes the resistance in the arc
 - b. varies the resistance in the arc
 - c. varies the voltage in the arc
 - d. varies the current in the arc

72.01.04.03.A2-2 12. Which of the following is the thermostat (see plan)?

- a. single-pole single-throw
- b. double-pole double-throw
- c. double-pole single-throw
- d. single-pole double-throw

13. How many wires must be run between an incandescent lamp and its dimmer control?

- a. five
- b. four
- c. three
- d. two

14. What is the height of the telephone jack from the finish floor in the living room (see plan)?

- a. 48" to center
- b. 50" to center
- c. 4' 11" to center
- d. 2' 11" to center

15. Where in the living room is the telephone jack located (see plan)?

- a. in the book case
- b. over the fireplace
- c. by the TV
- d. by the track fixture

72.01.04.04.A2-2 16. A phone jack has how many prongs on it?

- a. four
- b. three
- c. one
- d. two

17. What determines the design of wall plates to be used on a TV outlet?

- a. wall paneling
- b. other outlets
- c. television set

- 72.01.04.04.A2-2 18. Which of the following is usually used to obtain the operating voltage of door chimes?
- a. rheostat
 - b. ballast
 - c. transformer
 - d. humidistat
19. If a TV outlet is to have both the low voltage outlet and 120 voltage in one box, what must be provided?
- a. barrier between the two
 - b. a rheostat
 - c. it is not allowable
 - d. a switch
20. How many solenoids are contained in a two-tone chime?
- a. two
 - b. four
 - c. one
 - d. three
- 72.01.04.05.A2-2 21. Transformers on a Class 2 low-voltage system may not exceed which of the following?
- a. 80 volt amperes
 - b. 200 volt amperes
 - c. 100 volt amperes
 - d. 150 volt amperes
22. Which of the following changes AC current to DC or pulsating direct current?
- a. diode
 - b. rectifier
 - c. capacitor
 - d. relay
23. The low-voltage relay is essentially which of the following?
- a. a double rectifier
 - b. a double solenoid
 - c. a rectifier
 - d. a thermostat

- 2.01.04.05.A2-2 24. What size wire is usually used for low-voltage system?
- a. 16 AWG
 - b. 18 AWG
 - c. 14 AWG
 - d. 12 AWG
25. What type of switch is used for controlling relay of a low-voltage system?
- a. DTDP momentary
 - b. SPST momentary
 - c. SPDT momentary
 - d. DPDT momentary
- 2.01.04.06.A2-2 26. What type of switch is used for controlling relays of a low-voltage system?
- a. SPST momentary
 - b. DPDT momentary
 - c. SPDT momentary
 - d. DTDP momentary
27. Why do some manufacturers call for a rectifier to be installed on low voltage systems?
- a. to vary the resistance
 - b. to stabilize the voltage
 - c. to provide constant amperage
 - d. to stop heat build up
28. The low-voltage relay is essentially which of the following?
- a. thermostat
 - b. a double rectifier
 - c. a double solenoid
 - d. a rectifier
29. Which of the following is not an advantage of low-voltage systems?
- a. high cost
 - b. low cost
 - c. safe
 - d. easily installed
30. Wires on a low-voltage system must be separated from other conductors by a distance not less than which of the following?
- a. 1"
 - b. 2"
 - c. 3"
 - d. 4"

UNIT PRETEST ANSWER KEY: SIGNAL AND LOW VOLTAGE SYSTEMS

LAP 01

1. a
2. b
3. d
4. a
5. d

LAP 04

16. a
17. b
18. c
19. a
20. a

LAP 02

6. c
7. a
8. c
9. b
10. d

LAP 05

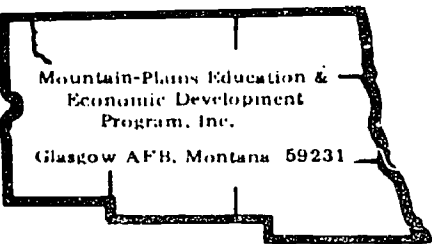
21. c
22. b
23. b
24. b
25. c

LAP 03

11. d
12. c
13. d
14. d
15. a

LAP 06

26. c
27. d
28. c
29. a
30. b



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Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Laying Out Signal Circuits on a Plan

OBJECTIVE:

Given the necessary tools, equipment, materials, supplies, and a floor plan, sketch in and label the signal circuits. Sketch must be complete with information and standards identified in the resource text. Identify the electrical requirements and procedures for sketching and laying out signal circuits for specified plans.

EVALUATION PROCEDURE:

Accurate completion of the sketch to the standards described in the text. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

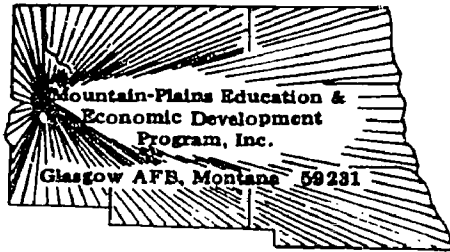
RESOURCES:

Electrical Wiring, Ray Mullin, pp. 201-212.
Series Circuits and Parallel Circuits.

PROCEDURE:

1. View film while listening to tape.
2. Read the text reference, pp. 201-212, Unit 22.
3. Answer the questions on pp. 209-212.
4. Using the floor plan (obtain from the instructor) and the resources listed as a reference, sketch on the blueprint the signal circuits necessary to comply with the resource specification.
NOTE: Make your sketches on the plan neat and clear. Follow the procedures presented in the text.
5. When you have completed steps 1-5, compile the requested data on your Performance Record.
6. Take the test for this LAP.
7. Score the LAP test and return it.
8. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

Principal Author(s): R. Arneson, L. Leland, T. Ziller



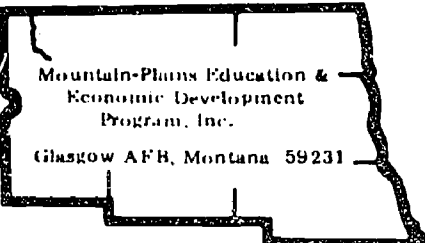
LAP TEST: LAYING OUT SIGNAL CIRCUITS ON A PLAN

1. Where is the permanent phone installed in this house (see plan and specs)?
 - a. living room
 - b. kitchen
 - c. bedroom 1
 - d. bedroom 2
2. A system using a volt ampere rating of less than 100 volt amperes is rated what class of door chime (see NEC)?
 - a. class three
 - b. class one
 - c. class four
 - d. class two
3. Most telephone companies require a minimum of how many phones to be installed in a house permanently?
 - a. one
 - b. three
 - c. four
 - d. two
4. A phone jack has how many prongs on it?
 - a. four
 - b. three
 - c. one
 - d. two
5. How many solenoids are contained in a two-tone chime?
 - a. two
 - b. four
 - c. one
 - d. three

6. Which of the following closes the circuit of a chime solenoid?
 - a. conductor
 - b. tone arm
 - c. plunger
 - d. push button
7. In which of the following must EMT be used for telephone service?
 - a. residence, no basement masonry
 - b. residence with basement masonry
 - c. residence, no basement
 - d. residence
8. At what height are the outlets for television in the bedrooms set (see plan)?
 - a. 12" to center
 - b. 2' 11" to center
 - c. 18" to center
 - d. 5" to center
9. What size wire is usually installed for signal system of the type in this residence? (See Plans)
 - a. 18 AWG
 - b. 14 AWG
 - c. 16 AWG
 - d. 12 AWG
10. What style of chimes are to be provided in this residence? (See Plans)
 - a. exposed
 - b. flush
 - c. nutone
 - d. variable

LAP TEST ANSWER KEY: LAYING OUT SIGNAL CIRCUITS ON A PLAN

1. b
2. d
3. a
4. a
5. a
6. d
7. a
8. a
9. a
10. b



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Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Determining Type of Signal System

OBJECTIVE:

Given the blueprint and specifications, identify and record the type and description of the signal system on a requisition form. Compiled data must correlate to and conform with the listed reference standards established in the industry. Identify the procedures for determining the type of signal system to use for a given set of specifications.

EVALUATION PROCEDURE:

Accurate ordering of the parts and supplies needed to complete the specific job listed in the objective and on the blueprint. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Supply Catalog.
Electrical Wiring, Ray C. Mullin, pp. 201-212.

PROCEDURE:

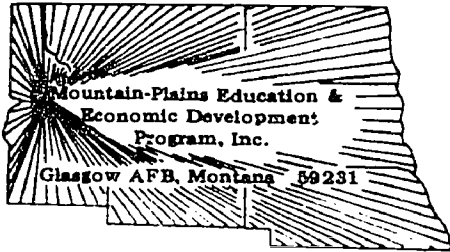
1. Obtain an Electrical Parts Supply Catalog.
2. Using the attached requisition and the blueprint sketch you have completed, order the parts and supplies needed to complete the job indicated in the objectives.
NOTE: Parts and supplies must be ordered by quantity, complete description and type.
3. Check the completed requisition with the answer key.
4. Enter the requested data on your Performance Record.
5. Take the test for this LAP.
6. Score the LAP test and return it.
7. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

Principal Author(s): R. Arneson, L. Ieland, T. Ziller

-ORIGINATOR'S CONTROL NO. -

ITEM NO.	QUAN.	UNIT	DESCRIPTION OF SUPPLIES / SERVICES	EST. UNIT PRICE	EST. AMOUNT

Title	Signature	Date	Title	Signature	Date
ORIGINATOR			PROPERTY CONTROLLER		
DEPT. HEAD			PROCUREMENT OFFICER		
DIRECTOR			ACCOUNTING OFFICE (To Procurement)		



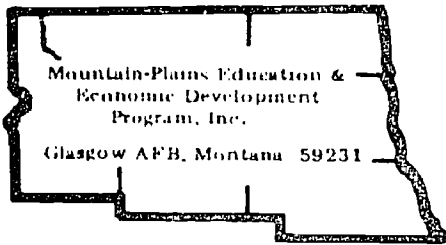
LAP TEST: DETERMINING TYPE OF SIGNAL SYSTEM

1. What type boxes are recommended when nonshielded lead-in wire is used for a telephone circuit?
 - a. DWV
 - b. nonmetallic
 - c. metal
 - d. special television
2. What is the OHM rating of the coaxial cable used to service each TV? (See Plans)
 - a. 100 OHM
 - b. 75 OHM
 - c. 300 OHM
 - d. 500 OHM
3. Unshielded TV input cable should not be installed near which of the following?
 - a. glass
 - b. wood members
 - c. pipes
 - d. plastic
4. A TV signal system that does not use an amplifier is called which of the following?
 - a. multiset coupler system
 - b. TV distribution system
 - c. bias/coupler distribution system
 - d. bias TV system
5. How many television outlets are installed in this residence (see plan)?
 - a. 6
 - b. 7
 - c. 5
 - d. 4

6. Older model TV's usually have which of the following impedance input ratings?
 - a. 300 OHM
 - b. 200 OHM
 - c. 100 OHM
 - d. 75 OHM
7. At what height should the TV outlets be installed (see specs)?
 - a. 12" oc
 - b. 16" oc
 - c. 18" oc
 - d. 24" oc
8. How many wires must a cable have that is run between a rotor on a TV antenna and its controller?
 - a. eight
 - b. six
 - c. two
 - d. four
9. What is the size outlet box to be used in this residence for the television outlets (see specs)?
 - a. $3 \frac{1}{2} \times 1 \frac{1}{2}$
 - b. $4 \times 2 \frac{1}{8}$
 - c. $4 \times 1 \frac{1}{2}$
 - d. $3 \frac{1}{4} \times 1 \frac{1}{2}$
10. What determines the design of wallplates to be used on a TV outlet?
 - a. television set
 - b. wall paneling
 - c. design of circuitry
 - d. other outlets

LAP TEST ANSWER KEY: DETERMINING TYPE OF SIGNAL SYSTEM

1. b
2. b
3. c
4. a
5. b
6. a
7. a
8. d
9. c
10. d



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Installing Dimmer Controls

OBJECTIVE:

Given the necessary tools, equipment, supplies and blueprint, correctly install an electronic dimmer control according to manufacturer's and blueprint specifications; following procedures and practices accepted in the industry and outlined in the reference text. Identify the procedures for installing an electronic dimmer control and recognize information related to such installation.

EVALUATION PROCEDURE:

Installation meets the criteria listed on the attached checklist. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray Mullin, pp. 98-110.
Manufacturer's Specifications.

PROCEDURE:

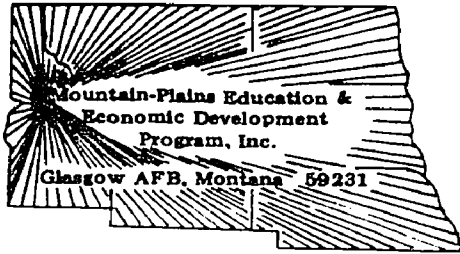
1. Listen to tape and study schematic Dimmer Controls.
2. Read the resource, pp. 98-110 and answer the questions on pp. 108-110.
3. Go to assigned work station where you will complete the activities listed in the objective.
4. Obtain the necessary tools, equipment and supplies needed to complete the operations listed.
5. Complete the job listed in the objective.
NOTE: FOLLOW SAFE PRACTICES AND PROCEDURES.
6. Perform all necessary testing and evaluation checks listed in the checklist. If you have any questions or problems, check with the instructor.
7. When you have been checked off on the checklist by the instructor, complete the data requested on your Performance Record and have him initial it.
8. Clean up the area.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

9. Take the test for this LAP.
10. Score the LAP test and return it.
11. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

CHECKLIST: INSTALLING DIMMER CONTROLS

- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.



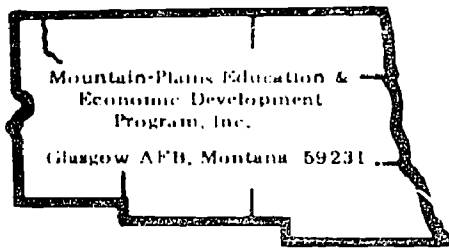
LAP TEST: INSTALLING DIMMER CONTROLS

1. How many wires are required between a fluorescent lamp and its dimmer (less grounding)?
 - a. five
 - b. two
 - c. four
 - d. three
2. When can dimmers be installed on fluorescent lights?
 - a. if they have a special ballast
 - b. if they have a special bulb
 - c. if they have a special switch
 - d. if they have a standard ballast
3. What function does the dimmer on a fluorescent light perform?
 - a. varies the voltage in the arc
 - b. varies the resistance in the arc
 - c. stabilizes the resistance in the arc
 - d. varies the current in the arc
4. With one exception the code book section 410-71 (E) requires that ballasts have:
 - a. a protector.
 - b. a potential relay.
 - c. a current relay.
 - d. a switch.
5. Which of the following is the thermostat (see plan)?
 - a. double-pole double-throw
 - b. double-pole single-throw
 - c. single-pole single-throw
 - d. single-pole double-throw

6. What type of switch is required to compensate for incandescent lamp load inrush?
 - a. Y rated switches
 - b. X rated switches
 - c. P rated switches
 - d. T rated switches
7. In the living room what type of fluorescent fixtures are used for the valence lighting?
 - a. **revolving start**
 - b. instant start
 - c. **rapid start**
 - d. trigger start
8. Where in the living room is the telephone jack located (see plan)?
 - a. by the track fixture
 - b. by the TV
 - c. over the fireplace
 - d. in the book case
9. On the plans provided which section indicates a multi-outlet assembly in the living room?
 - a. A-A
 - b. D-D
 - c. F-F
 - d. E-E
10. At what height is the thermostat in the living room installed (see the plans)?
 - a. 60" to center
 - b. **50" to center**
 - c. 48" to center
 - d. 52" to center

LAP TEST ANSWER KEY: INSTALLING DIMMER CONTROLS

1. d
2. a
3. d
4. a
5. b
6. d
7. b
8. d
9. c
10. b



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Installing Signal Systems

OBJECTIVE:

Given the necessary tools, equipment, supplies and blueprint, correctly install a signal system according to manufacturer's and blueprint specifications; following procedures and practices accepted in the industry and outlined in the reference text. Identify the procedures for installing a signal system and the related information about components to be installed.

EVALUATION PROCEDURE.

Installation meets the criteria listed on the attached checklist. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

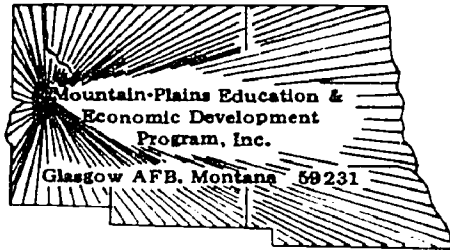
Electrical Wiring, Ray Mullin, pp. 201-212.
Manufacturer's Specifications.

PROCEDURE:

1. Read the resource, pp. 201-212 and answer the questions on pages 209-212.
 2. Go to your assigned work station where you will complete the activities listed in the objective.
 3. Obtain the necessary tools, equipment and supplies needed to complete the operations listed.
 4. Complete the job listed in the objective.
- NOTE: FOLLOW SAFE PRACTICES AND PROCEDURES.
5. Perform all necessary testing and evaluation checks listed in the checklist. If you have any questions or problems, check with instructor.
 6. When you have been checked off on the checklist by the instructor, complete the data requested on your Performance Record and have him initial it.
 7. Clean up the area.

Principal Author(s): R. Arneson, L. Ieland, T. Ziller

8. Take the test for this LAP.
9. Score the LAP test and return it.
10. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.



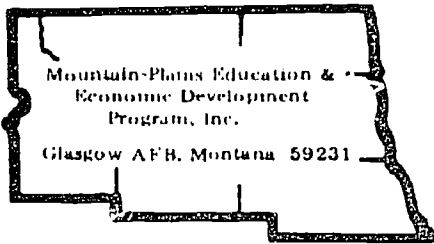
LAP TEST: INSTALLING SIGNAL SYSTEMS

1. How many telephone locations are provided in this house (see plan)?
 - a. two
 - b. five
 - c. three
 - d. four
2. What size is the outlet box to be used in this residence for the television outlets (see specs)?
 - a. $3\frac{1}{2} \times 1\frac{1}{2}$
 - b. $4 \times 1\frac{1}{2}$
 - c. $3\frac{1}{4} \times 1\frac{1}{2}$
 - d. $4 \times 2\frac{1}{8}$
3. In which of the following must EMT be used for telephone service?
 - a. residence
 - b. residence with **basement, masonry**
 - c. residence, no basement
 - d. residence, no **basement, masonry**
4. Most telephone companies require a minimum of how many phones to be installed in a house permanently?
 - a. three
 - b. one
 - c. four
 - d. two
5. How high is the permanent phone installed (see plan)?
 - a. 5' to center
 - b. 4' to center
 - c. 5' 2" to center
 - d. 5' 6" to center

6. A phone jack has how many prongs on it?
 - a. four
 - b. one
 - c. two
 - d. three
7. If a TV outlet is to have both the low-voltage outlet and 120 voltage in one box, what must be provided?
 - a. barrier between the two
 - b. a switch
 - c. it is not allowable
 - d. a rheostat
8. How many tones do the chimes in this residence have (see specs)?
 - a. four
 - b. two
 - c. one
 - d. eight
9. How many solenoids are contained in a two-tone chime?
 - a. one
 - b. four
 - c. three
 - d. two
10. What determines the design of wall plates to be used on a TV outlet?
 - a. design of circuitry
 - b. television set
 - c. other outlets
 - d. wall paneling

LAP TEST ANSWER KEY: INSTALLING SIGNAL SYSTEMS

1. b
2. b
3. d
4. b
5. a
6. a
7. a
8. b
9. d
10. c



Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Laying Out Low-Voltage Circuits on a Plan

OBJECTIVE:

Given the necessary tools, equipment, materials, supplies, and a floor plan, sketch in and label the low-voltage circuits. Sketch must be complete with information and standards identified in the resource text. Identify the electrical procedures requirements for sketching and laying out low-voltage circuits that meet given specifications.

EVALUATION PROCEDURE:

Accurate completion of the sketch to the standards described in the text. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray C. Mullin, pp. 262-272.

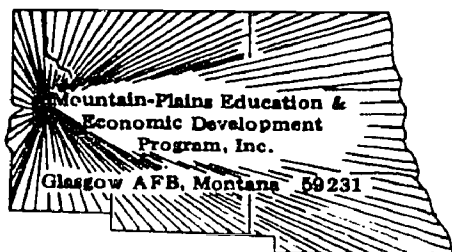
PROCEDURE:

1. Read the text reference, pp. 262-272, Unit 28.
2. Answer the questions on pp. 270-272.
3. Using the floor plan (obtain from the instructor) and the resources listed as reference, sketch on the blueprint the low-voltage circuits necessary to comply with the resource specifications.
NOTE: Make your sketches on the plan neat and clear. Follow the procedure presented in the text.
4. When you have completed steps 1-4, compile the requested data on your Performance Record.
5. Go to your instructor for evaluation and checkoff. Have the instructor initial your Performance Record in the appropriate space.
6. Take the test for this LAP.
7. Score the LAP test and return it.
8. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

CHECKLIST: LAYING OUT LOW-VOLTAGE CIRCUITS ON A PLAN

- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.



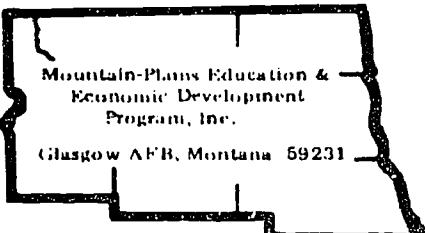
LAP TEST: LAYING OUT LOW-VOLTAGE CIRCUITS ON A PLAN

1. Which of the following is not used in a low-voltage system?
 - a. S1
 - b. S3
 - c. DPDT
 - d. SPDT Momentary
2. Which of the following sections in the NEC governs low-voltage systems?
 - a. 725-33
 - b. 230-16 (A)
 - c. 275-4 (B)
 - d. 537-9 (A)
3. Wires on a low-voltage system must be separated from other conductors by a distance not less than which of the following?
 - a. 3"
 - b. 4"
 - c. 1"
 - d. 2"
4. Transformers or other devices supplied from light circuits must be protected by an over current device not exceeding which of the following (Class II)?
 - a. 30 amps
 - b. 10 amps
 - c. 20 amps
 - d. 15 amps
5. Which of the following is not a advantage of low-voltage systems?
 - a. safe
 - b. easily installed
 - c. low cost
 - d. high cost

6. What is the approximate voltage used on low-voltage remote control systems?
 - a. 8 volts
 - b. 32 volts
 - c. 24 volts
 - d. 16 volts
7. On a low-voltage relay the blue lead is which of the following?
 - a. none of the below
 - b. common to both coils
 - c. common to the OFF coil
 - d. common to the ON coil
8. What size wire is usually used for low-voltage systems?
 - a. 12 AWG
 - b. 18 AWG
 - c. 14 AWG
 - d. 16 AWG
9. What type of switch is used for controlling relays of a low-voltage system?
 - a. DTDP Momentary
 - b. DPDT Momentary
 - c. SPDT Momentary
 - d. SPST Momentary
10. Transformers on a Class 2 low-voltage system may not exceed which of the following?
 - a. 200 volt amperes
 - b. 150 volt amperes
 - c. 100 volt amperes
 - d. 80 volt amperes

LAP TEST ANSWER KEY: LAYING OUT LOW-VOLTAGE CIRCUITS ON A PLAN

1. b
2. a
3. d
4. c
5. d
6. c
7. b
8. b
9. c
10. c



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Learning Activity Package

Student: _____

Date: _____

PERFORMANCE ACTIVITY: Installing Low-Voltage Wiring Systems

OBJECTIVE:

Given the necessary tools, equipment, supplies and blueprint, correctly install a low-voltage wiring system according to manufacturer's and blueprint specifications; following procedures and practices accepted in the industry and outlined in the reference text. Identify the procedures for installing a low-voltage system and the related information about the components involved.

EVALUATION PROCEDURE:

Installation meets the criteria listed on the attached checklist. Complete, score and return a ten-item multiple-choice test about this LAP. Successful completion is eight out of ten items.

RESOURCES:

Electrical Wiring, Ray Mullin, pp. 262-272.
Manufacturer's Specifications.

PROCEDURE:

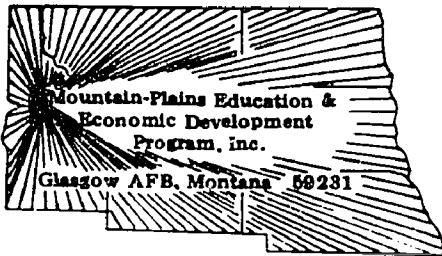
1. Read the resource, pp. 262-272 and answer the questions on pages 270-272.
2. Go to the assigned work station where you will complete the activities listed in the objective.
3. Obtain the necessary tools, equipment and supplies needed to complete the operations listed.
4. Complete the job listed in the objective.
NOTE: FOLLOW SAFE PRACTICES AND PROCEDURES.
5. Perform all necessary testing and evaluation checks listed in the checklist. If you have any questions or problems, check with the instructor.
6. When you have been checked off on the checklist by the instructor, complete the data requested on your Performance Record and have him initial it.

Principal Author(s): R. Arneson, L. Leland, T. Ziller

7. Clean up the area.
8. Take the test for this LAP.
9. Score the LAP test and return it.
10. If the test is satisfactory, begin the next assigned LAP. If the test is unsatisfactory, proceed as directed by the instructor.

CHECKLIST: INSTALLING LOW-VOLTAGE WIRING SYSTEMS

- _____ 1. Proper selection and use of tools, equipment and supplies.
- _____ 2. Safe practices and procedures followed.
- _____ 3. Neat and presentable.
- _____ 4. Meets or exceeds standards established in the industry.
- _____ 5. Procedures followed are practiced and accepted in the industry.



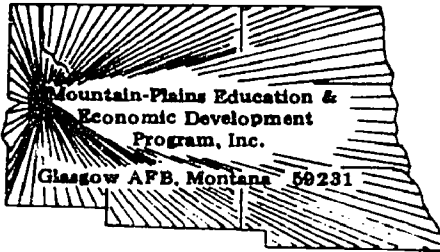
LAP TEST: INSTALLING LOW-VOLTAGE WIRING SYSTEMS

1. Wires on a low-voltage system must be separated from other conductors by a distance not less than which of the following?
 - a. 1"
 - b. 4"
 - c. 3"
 - d. 2"
2. Transformers or other devices supplied from light circuits must be protected by an over current device not exceeding which of the following (Class II)?
 - a. 20 amps
 - b. 15 amps
 - c. 30 amps
 - d. 10 amps
3. What type of switch is used for controlling relays of a low-voltage system?
 - a. SPST Momentary
 - b. DTDG Momentary
 - c. SPDT Momentary
 - d. DPDT Momentary
4. Which of the following is not an advantage of low-voltage systems?
 - a. high cost
 - b. low cost
 - c. safe
 - d. easily installed
5. What is the approximate voltage used on low-voltage remote control systems?
 - a. 8 volts
 - b. 16 volts
 - c. 32 volts
 - d. 24 volts

6. Which of the following sections in the NEC governs low-voltage systems?
- a. 725-33
 - b. 275-4 (B)
 - c. 537-9 (A)
 - d. 230-16 (A)
7. On a low-voltage relay the blue lead is which of the following?
- a. none of the above
 - b. common to the ON coil
 - c. common to the OFF coil
 - d. common to both coils
8. Which of the following is not used in a low-voltage system?
- a. DPDT
 - b. SPDT Momentary
 - c. S1
 - d. S3
9. The low-voltage relay is essentially which of the following?
- a. rectifier
 - b. a double solenoid
 - c. a thermostat
 - d. a double rectifier
10. Transformers on a Class 2 low-voltage system may not exceed which of the following?
- a. 200 volt amperes
 - b. 150 volt amperes
 - c. 80 volt amperes
 - d. 100 volt amperes

LAP TEST ANSWER KEY: INSTALLING LOW-VOLTAGE WIRING SYSTEMS

1. d
2. a
3. c
4. a
5. d
6. a
7. d
8. d
9. b
10. d



UNIT POST TEST: SIGNAL AND LOW VOLTAGE SYSTEMS

- 2.01.04.01.A2-2
1. At what height are the outlets for television in the bedrooms set (see plan)?
 - a. 12" to center
 - b. 5" to center
 - c. 18" to center
 - d. 2' 11" to center
 2. Systems using a volt ampere rating of less than 100 volt amperes is rated what class of door chime (see NEC)?
 - a. class two
 - b. class one
 - c. class four
 - d. class three
 3. An energy limiting transformer limits load over current to which of the following?
 - a. 4 amps
 - b. 20 amps
 - c. 8 amps
 - d. 30 amps
 4. Which of the following closes the circuit of a chime solenoid?
 - a. tone arm
 - b. plunger
 - c. conductor
 - d. push button
 5. Which of the following is usually used to obtain the operating voltage of door chimes?
 - a. humidistat
 - b. rheostat
 - c. ballast
 - d. transformer

- 72.01.04.02.A2-2 6. What is the size outlet box to be used in this residence for the television outlets (see specs)?
- $3 \frac{1}{4} \times 1 \frac{1}{2}$
 - $4 \times 2 \frac{1}{8}$
 - $3 \frac{1}{2} \times 1 \frac{1}{2}$
 - $4 \times 1 \frac{1}{2}$
7. Older model TV's usually have which of the following impedance input ratings?
- 200 OHM
 - 300 OHM
 - 100 OHM
 - 75 OHM
8. How many wires must a cable have that is run between a rotor on a TV antenna and its controller?
- eight
 - six
 - two
 - four
9. What determines the design of wall plates to be used on a TV outlet?
- wall paneling
 - other outlets
 - design of circuitry
 - screw mounts
10. Television boxes are to have which of the following (see specs)?
- knockouts
 - plaster covers
 - nail mounts
 - screw mounts
- 72.01.04.03.A2-2 11. How many wires are required between a fluorescent lamp and its dimmer (less grounding)?
- four
 - three
 - five
 - two

- 72.01.04.03.A2-2 12. At what height is the thermostat in the living room installed at (see plans)?
- a. 52" to center
 - b. 60" to center
 - c. 50" to center
 - d. 48" to center
13. On the plans provided which section indicates a multi-outlet assembly in the living room?
- a. E-E
 - b. F-F
 - c. A-A
 - d. D-P
14. When can dimmers be installed on fluorescent lights?
- a. if they have a special switch
 - b. if they have a special ballast
 - c. if they have a special bulb
 - d. if they have a standard ballast
15. With one exception the code book section 410-71 (E) requires that ballasts have what?
- a. a current relay
 - b. a protector
 - c. a switch
 - d. a potential relay
- 72.01.04.04.A2-2 16. In which of the following must EMT be used for telephone service?
- a. residence with basement masonry
 - b. residence, no basement masonry
 - c. residence
 - d. residence, no basement
17. How many telephone locations are provided in this house (see plan)?
- a. four
 - b. five
 - c. two
 - d. three

- 2.01.04.04.A2-2 18. An energy limiting transformer limits load short circuit current to which of the following:
- a. 30 amps
 - b. 8 amps
 - c. 20 amps
 - d. 4 amps
19. How many wires must a cable have that is run between a rotor on a TV antenna and its controller?
- a. six
 - b. four
 - c. two
 - d. eight
20. How many tones do the chimes in this residence have (see specs)?
- a. one
 - b. eight
 - c. four
 - d. two
- 72.01.04.05.A2-2 21. Which of the following sections in the NEC governs low voltage systems?
- a. 537-9 (A)
 - b. 230-16 (A)
 - c. 275-4 (B)
 - d. 725-33
22. On a low voltage relay the blue lead is which of the following?
- a. common to the OFF coil
 - b. common to both coils
 - c. common to the ON coil
 - d. none of the above
23. Which of the following is not used in a low voltage system?
- a. S1
 - b. DPDT
 - c. SPDT Momentary
 - d. S3

2.01.04.05.A2-2 24. Which of the following is not an advantage of low voltage system?

- a. high cost
- b. low cost
- c. safe
- d. easily installed

25. Why do some manufacturers call for a rectifier tube installed on low voltage systems?

- a. to stop heat build up
- b. to vary the resistance
- c. to provide constant amperage
- d. to stabilize the voltage

72.01.04.06.A2-2 26. Transformers on a Class 2 low voltage systems may not exceed which of the following?

- a. 150 volt amperes
- b. 80 volt amperes
- c. 200 volt amperes
- d. 100 volt amperes

27. Transformers or other devices supplies from light circuits must be protected by an over current not exceeding which of the following?

- a. 10 amps
- b. 30 amps
- c. 15 amps
- d. 20 amps

28. Which of the following sections in the NEC governs low voltage systems?

- a. 725-33
- b. 130-16 (A)
- c. 537-9 (A)
- d. 275-4 (B)

29. Which of the following is not used in a low voltage system?

- a. S1
- b. S3
- c. DPDT
- d. SPDT Momentary

30. Which of the following changes AC current to DC or pulsating direct current?

- a. capacitor
- b. diode
- c. relay
- d. rectifier

UNIT POST TEST ANSWER KEY: SIGNAL AND LOW VOLTAGE SYSTEMS

LAP 01

1. a
2. a
3. b
4. d
5. d

LAP 04

16. b
17. b
18. b
19. b
20. d

LAP 02

6. d
7. b
8. d
9. b
10. b

LAP 05

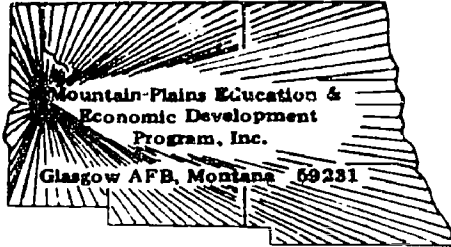
21. d
22. b
23. d
24. a
25. a

LAP 03

11. b
12. c
13. b
14. b
15. b

LAP 06

26. d
27. d
28. a
29. b
30. d



Family Pay Number: _____ Sex: M F (Circle 1)

UNIT PERFORMANCE TEST: SIGNAL AND LOW VOLTAGE SYSTEMS

OBJECTIVE 1:

Given a blueprint of a floor plan, the student will make a sketch of electrical signal and low voltage systems.

OBJECTIVE 2:

Given a blueprint, the student will determine and obtain the materials necessary to complete the signal and low voltage installation.

OBJECTIVE 3:

The student will properly install signal and low voltage systems.

TASK:

The student will be given a floor plan of a particular room. The student will sketch the required signal and low voltage electrical systems; obtain equipment and supplies, and install the required signal and low voltage electrical system as prescribed by the National Electrical Code and Blueprint specifications.

ASSIGNMENT:CONDITIONS:

The student will be tested in a wood frame construction to simulate any specified room of a residence. The student will be given necessary tools and equipment. No assistance may be obtained from another student or the instructor or from unspecified text material.

RESOURCES:

Tools:

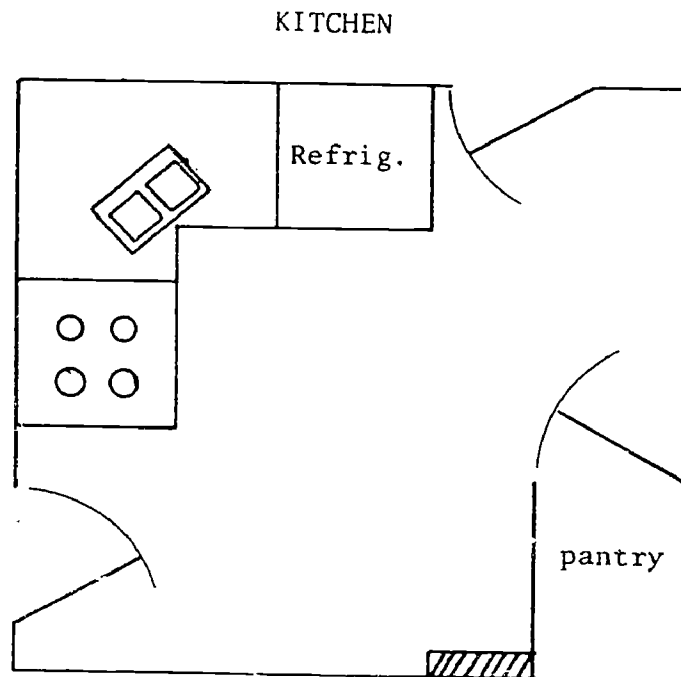
- High leverage plier
- High leverage oblique cutting plier
- Long nose cutting plier
- Electrician's hammer
- Screwdriver slot 3/16 x 4
- Screwdriver no. 2 phillips 8"
- Screwdriver slot 3/16 x 9
- Screwdriver 1/4 x 4
- Screwdriver 1/4 x 6
- Nutdriver variable size 1/4" x 7/16
- Scratch awl
- Adjustable Wrench size 8"
- Pump plier size 10"
- All-purpose tool, wire stripper, crimper and cutter
- Tape rule 12' 3/4"
- Knife, electricians
- Tool pouch, 5 pocket

Equipment:

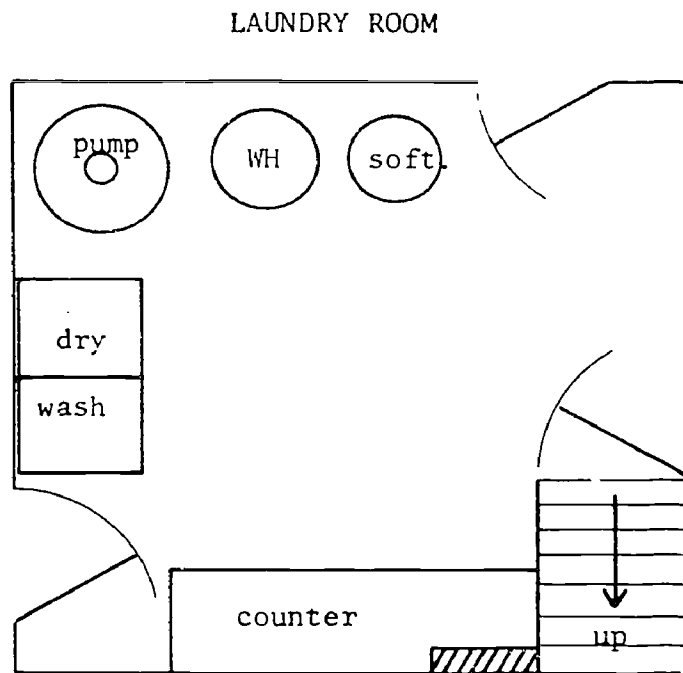
- Simpson 260 VOM or Amprobe

Text:

- Electrical Wiring Residential, Ray C. Mullin, Delmar Publishers, 4th Ed., 1973
- National Electrical Code

ASSIGNMENT SHEET 1

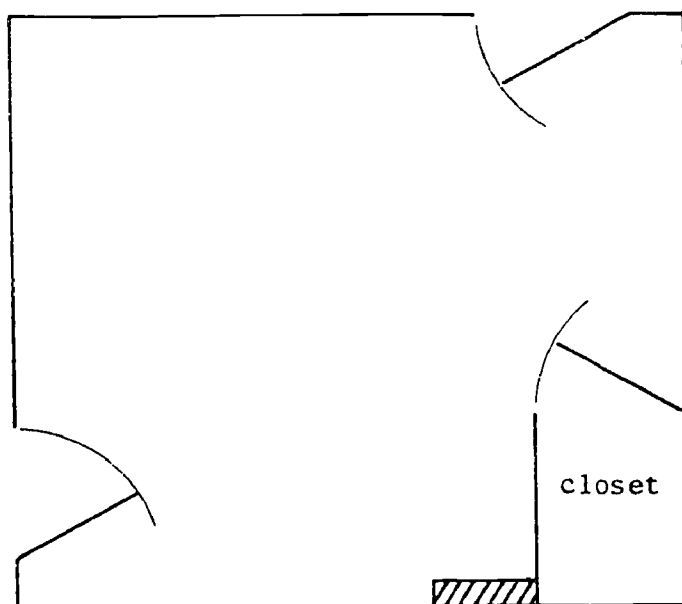
- garbage disposal
- pantry light
- light 2-position control

ASSIGNMENT SHEET 2

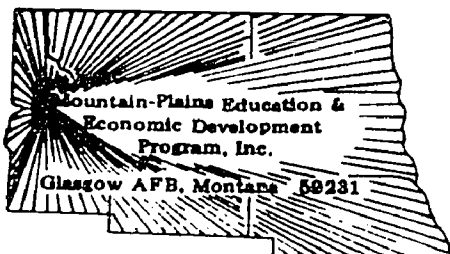
- sub-pump
- water heater
- water softener
- 3-position switch control

ASSIGNMENT SHEET 3

LIVING ROOM



--electric heat
--split receptacles
--2-position switch control



Family Pay Number: _____ Sex: M F (Circle 1)

PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory _____ Unsatisfactory _____

	CRITERION	
	Met	Not Met
Objective 1:		
1. The student properly prepares a sketch of a floor plan to		
determine location of signal and low voltage electrical		
systems.		
Criterion: The student uses the sketch while making the installation of the		
signal and low voltage electrical systems.		
Objective 2:		
2. The student determines the proper types of signal and low		
voltage electrical systems.		
3. The student determines the proper sizes of wires in		
signal and low voltage electrical systems.		
4. The student determines the proper controls in signal		
and low voltage electrical systems.		
Criterion: The electrical specifications and installation		
meet National Electrical Code and floor plan		
specifications.		
Objective 3:		

(Checklist continued)

CRITERION

Met Not Met

5. The student properly installs the transformer circuit.		
6. The student properly installs the transformer.		
7. The student properly installs the low voltage circuit wiring.		
8. The student properly installs the low voltage circuit control.		
9. The student properly installs the signal circuit wiring.		
10. The student properly installs the signal circuit control.		
11. The student properly installs the signal circuit's alarm device.		
Criterion: The electrical specifications and installation meet National Electrical Code standards and floor plan specifications.		
12. Task completed in allotted time.		
Criterion: See assignment for time specifications.		
Student must meet criterion on all line items to obtain an overall score of satisfactory.		